TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

SYNOPSIS

OF THE

EXTINCT BATRACHIA, REPTILIA AND AVES OF NORTH AMERICA.

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PREFACE.

It is not designed in the present essay, to give descriptions of the known remains of the Batrachia, Reptiles and Birds, which have been more or less fully made known by others. This is left for the day when our knowledge shall more nearly approach completeness. While the subject is in its infancy, I have thought best to describe only those species and types which are new, and those portions of imperfectly known forms which will throw additional light on their relations and affinities. In adhering to this plan, I have been able to add no little to the history of the Reptiles already described by my predecessors, Leidy, Owen, Dawson, Wyman, Lea, etc. Where, however, I have had nothing to add, I have referred to their published descriptions, which are numerous and well-known. The literature of the subject will then be found under the respective specific heads.

The present Memoir was originally prepared under the title of "Contributions to the History of the Vertebrates of the Mesozoic Periods in New Jersey and Pennsylvania," and presented to the Academy of Natural Sciences of Philadelphia, for publication, Fifth Month, 14, 1867. The more important parts of its contents were at the same time embodied in a series of remarks before the Academy. This essay was withdrawn, owing to delay in the publication, and the remarks made were not printed. An abstract of part

of them was, however, published in the Proceedings of the Academy for the same year, page 234.

Additional material was shortly afterwards sent to the writer, and the important contributions on the Batrachia of the coal measures, and on the Elasmosauridæ, written. The Palaeophis and some of the Testudinata and Pythonomorpha were also added.

In the course of these investigations, prosecuted during the past six years, with reference to the structure and relations of the extinct Reptilia, the following general conclusions have been attained to, besides many of lesser significance.

First: That the Dinosauria present a graduated series of approximations to the birds, and possess some peculiarities in common with that class, standing between it and the Crocodilia.

Second: That serpents exist in the Eocene formations of this Country.

Third: That the Chelydra type was greatly developed during the American Cretaceous, and that all the supposed marine turtles described from it, are really of the first named group.

Fourth: That the Reptilia of the American Triassic are of the Belodon type.

Fifth: The discovery of the characters of the order Pythonomorpha.

Sixth The development of the characters of numerous members of the Batrachian Sub-order Microsauria in the United States.

I must express my obligations to Prof. Geo. H. Cook, of the Geological Survey of New Jersey, who kindly placed the specimens procured during the Survey at my disposal. I am also particularly indebted to Prof. John S. Newberry, of Columbia College, New York, and director of the Geological Survey of Ohio, for the loan of the unique and important material from the carboniferous beds at Linton, Ohio, contained in his private collection. I am under similar obligations to Wm. R. Webb, Superintendent of the Land Office at Topeka, Kansas, for the important type specimens of Polycotylus latipinnis, and to Prof. Agassiz, for the freedom of study and description of the unequalled Mosasauroid material in the Museum of Comparative Zoology, Cambridge. Also to Philip P. Tyson, of Baltimore, for similar advantages, and to Dr. Theophilus M. Turner, of Fort Wallace, Kansas, for the discovery of that extraordinary reptile, the Elasmosarus platyurus, and its shipment in unusually good condition. Dr. E. R. Showalter, of Uniontown, Alabama, has placed me under obligation, in sending the beautiful fossil of Clidastes propython. I must also express obligations to Prof Marsh, of Yale College, Dr. Lockwood, of Keyport, New Jersey, and to other friends.

SYNOPSIS OF THE PRIMARY TYPES EMBRACED IN THIS ESSAY.

THE Classes Aves, Reptilia, and Batrachia are those over which the present review extends. The classes of veretebrata not included are: the Dipnoi, Pisces, Elasmobranchi, Dermopteri, and Leptocardii and the Mammalia.

The Aves, Reptilia, and Batrachia are characterized and distinguished from all the other classes as follows: the points wherein they differ from each other are italicized.

BATRACHIA.

Axial element of the brain chamber a single membrane bone, the parasphenoid; occipital condyles two, on the exoccipitals.

Mandible compound, supported by quadratum.

A distinct coracoid bone.

Limbs when present ambulatory, attached anteriorly to a scapular arch which is free from the cranium.

Nervous System. Cerebral hemispheres larger than optic lobes, *not covering the optic thalami, and with the lateral ventricle on their inner side.*

Fornix and arbor vitæ none; *medulla oblongata straight; olfactory lobes terminal, sessile.*

Circulatory System. Heart with two and three chambers.

Three or more aorta bows; aorta with two roots from a ductus communis *and bulbus arteriosus.*

REPTILIA.

Axis of brain case, the basi-occipital and sphenoid elements developed in the primordial cartilage, the first with exoccipitals bearing one condyle.

Mandible compound, supported by quadratum.

Coracoid bone distinct.

Limbs the anterior attached to a scapular arch which is free from cranium.

Metatarsals and metacarpals distinct; carpals and second row of tarsals also distinct; usually the first row of tarsals also.

Pubis not in contact with ischia distally.

Nervous System. Cerebral hemispheres larger than optic lobes, *extending over and concealing optic thalami, and with the lateral ventricles on their outer side.*

Fornix and arbor vitæ none; *medulla oblongata abruptly curved; olfactory lobes terminal pedunculate.*

Circulatory System. Heart with three or four chambers.

Aorta with two roots, and rarely an additional bow; no bulbus arteriosus.

AVES.

Osseous structure as in Reptilia, except metatarsal and usually metacarpal bones are confluent with each other, and with the carpal and second series of tarsal bones; first series of tarsals confluent with tibia.

Pubis turned backwards and more or less confluent with ischium.

Nervous System. Cerebral hemispheres larger than optic lobes, and concealing optic thalami with the lateral ventricle.

Fornix and arbor vitæ present; medulla oblongata bent; olfactory lobes inferior sessile.

Circulatory System. Heart with four chambers.

Aorta with one root turning to the right, no bows, and no bulbus arteriosus.

Class I.—BATRACHIA.

The vomer is double, and usually bears teeth in this class; the premaxillary is single or double.* Teeth never planted in deep alveoli.

There are six orders, as follows:

TRACHYSTOMATA.

Caudal vertebræ and frontal bones distinct. Inferior pelvic elements not confluent.

O. o. maxillaria, prefrontalia, palatina and pterygoidea wanting; nasalia present.

Ethmoid, two lateral pieces, each forming part of palate.

Mandible toothless, condyloid, teeth pleurodont. No "postorbital and supertemporal bones." First pair ceratohyals distinct.

* Two premaxillary bones are usually ascribed to the Batrachia, but in many Salamanders they are confluent. Thus while they are double in Salamandra, they are single in Hemisalamandra, Triton and Diemyctylus. In Amblystomidæ they are double. Among Plethodontidæ, they vary. Of Plethodontine genera Batrachoseps and Stereochila (Cope gen. nov. for *Pseudotriton marginatus* Hallow) have them single, and Plethodon double. Of Spelerpine forms, Manculus (Cope gen. nov. for *Salamandra quadridigitata* Holbr.) Oedipus and Spelerpes have but one, and Geotriton and Gyrinophilus (Cope gen. nov. for *Salamandra salmonea* Storer *Pseudotriton salmoneus* Bd.) have two premaxillaries. Desmognathus and Amphiuma have single premaxillaries.

PROTEIDA.

Caudal vertebræ and frontal bones distinct. Inferior pelvic elements not confluent.
O. o. maxillaria, prefrontalia and nasalia wanting; palatina and pterygoidea present.
Ethmoid* a vertical plate on each side the cerebral lobes.
Mandible toothed, teeth pleurodont. Ceratohyals, first pair connate.
No "postorbital and supertemporal bones."

URODELA.

Usual cranial bones present, but pterygoids reduced or wanting.
No "postorbital or supertemporal bones."
Caudal vertebræ and frontal bones distinct.
Ethmoid, a vertical plate on each side.
Mandible dentigerous; teeth pleurodont.
Inferior pelvic elements horizontal, in contact; no osseous pubis; ilium suspended to a sacral rib.
(Mostly no quadratojugal.)

GYMNOPHIDIA.

Usual cranial bones present and distinct, including frontals and pterygoids.
Caudal vertebræ distinct.
No "postorbital or supertemporal bones."†
Ethmoid annulus surrounding cerebral lobes.
Mandible dentigerous; teeth anchylosed by their bases.‡
(A quadratojugal.)

* Erroneously called orbitosphenoids by me. Journal Acad. 1866, (on Anura.)

† When the temporal fossa is overarched, it is by expansion of the maxillary and quadratojugal. (Stannius says, "Squama temporalis.")

‡ The teeth of Cæcilia are compressed with a trenchant posterior edge, which is crenate after the manner of Megalosaurus, Carcharias, etc. Thus to the numerous genera of Saurians and Selachians possessing this character, must be added a Batrachian.

STEGOCEPHALI.

Usual cranial elements distinct, including frontals and pterygoids, and adding "postorbitals and supertemporals."

Caudal vertebræ?

Orbitosphenoids normal.

Inferior pelvic elements distinct.

Mandible dentigerous; teeth with anchylosed bases, or in shallow alveoli.

Ethmoid. ?

(A quadratojugal.)

ANURA.

Frontal and parietal confluent, nasals wanting or rudimental; other cranial bones present.

Postorbital, supratemporal, and usually nasals wanting.

Ethmoid an annulus (usually complete above) surrounding cerebral lobes.

Caudal vertebræ represented by an elongate compound style.

Inferior elements of the pelvis consolidated into a single vertical mass; ilium attached immediately to sacral vertebræ.

STEGOCEPHALI.

XENORHACHIA.

The vertebral centra not ossified; the teeth simple; no branchial hyal bones; occipital condyles.

MICROSAURIA.

Vertebral centra ossified; no branchial hyoids; teeth simple or with slightly inflected enamel of the basis; occipital condyles.

GANOCEPHALA.

Vertebral centra cartilaginous; branchial hyoids present; teeth with inflected enamel, anchylosed by their bases. No ossified occipital condyles.

LABYRINTHODONTIA Vera.

Vertebral centra osseous; no branchial hyoids; teeth with much inflected enamel, anchylosed in shallow alveoli. Occipital condyles.

Our knowledge of these forms is as yet in many cases too incomplete, to enable us to assert positively as to the structure and position of the teeth, and the preceding arrangement is designed to shadow out the true system, rather than to define the groups exactly. They may be arranged further in the following manner, with reference to the dermal armature.

I. Three large pectoral plates.

α Abdomen with numerous short or long bony scales in close series.

β A bony sclerotic ring.

Teeth simple. *Xenorhachia.* — Amphibamus.

Teeth complex. *Ganocephala.* — Archegosaurus.

ββ No bony ring.

Microsauria. — Colosteus n. gen. Pholidogaster. Pteroplax. Cerаterpeton. Urocordylus.

II. No pectoral osseous shields.

α Abdomen with oblique series of long or short scales.

Microsauria. — Sauropleura. Œstocephalus. Lepterpeton. Ophiderpeton. Hylonomus. Dendrerpeton.

αα No abdominal scales known.

Pelion. Molgophis.

XENORHACHIA.

This order I proposed for the reception of the genus Amphibamus Cope, in 1865. I proposed to regard as one of its characters, the existence of opisthocœlian vertebræ. Such impressions were observed in the matrix in which the fossil was preserved, as to induce a

belief in the existence of such vertebræ, and the existence of these in a well ossified condition, in the apparently nearly allied genus Raniceps Wyman strengthened such belief. There were actually, however, only osseous neural arches present, and I am now decidedly of the opinion that the vertebral centra were either cartilaginous or annuliform, as in Archegosaurus.

AMPHIBAMUS, *Cope.*

Proc. Acad. Nat. Sci. Philadelphia, 1865. 134.

AMPHIBAMUS GRANDICEPS, *Cope.*

Proc. Acad. Nat. Sci. Philadelphia, 1865, 134. Palæntology, Ill. State Survey, Tab.
Carboniferous; Lower Coal Measures; Morris County, Illinois.

MICROSAURIA.

This suborder was established by Prof. Dawson for small lizard-like vertebrates from the Coal Measures, which he thought presented points of affinity to the Saurium reptiles, at the same time recognizing Batrachian characteristics.

These creatures form, in fact, a series closely resembling or parallel with what was probably an immature stage of the Labyrinthodontia. They are, Labyrinthodonts, with simple, or very slightly inflected enamel of the teeth, and with the extent of the exostosis of the cranial bones much reduced. This character has been much overrated by some authors. In the Dendrerpeton obtusum Cope the grooving and pitting exists only on the posterior parts of the cranium, and gradually disappears anteriorly. In the Alligator mississippiensis the same is the case.

The only species, included in this tribe, in which inflections of the enamel have been described is the Dendrerpeton acadianum, and here it is only at the base of the tooth. It is, however, not impossible that this genus should not be associated with Hylerpeton, Œstocephalus, etc.

The genera Urocordylus, Ceraterpeton, Lepterpeton, Ophiderpeton, and others recently described by Prof. Huxley, also belong here.

The genus Brachydectes m. is established on portions of the crania only, while Sauropleura m. is known from portions of all the skeleton except the cranium. There is, therefore, a possibility of a *double emploi* in this case, though not in respect to the species.

PELION, *Wyman.*

Proc. Acad. Natl. Sci. Philadelphia, 1868, p. 211. *Raniceps,* Wyman Amer. Journal Sci. and Arts, 1858, p. 158. Not of Cuvier, (Pediculati.)

PELION LYELLII, *Wyman.* *Raniceps lyeelii, Wyman, l. c.*

This animal differs from the genus Amphibamus, in the well ossified vertebral axis; no remains of a tail with elevated neural spines exist in the type specimen, nor have ventral scales or sclerotic bones been seen.

Middle Coal Measures, Jefferson county, Eastern Ohio.

HYLONOMUS, *Dawson.*

This genus embraces the smallest species of the order. They all pertain to that interesting Batrachian fauma of the Coal Measures of the Joggins of Nova Scotia, elucidated chiefly through the exertions of Principal Dawson, of Montreal. This fauma embraces six of the Microsauria and one true Labyrinthodont. Of the former, the Hylerpeton dawsonii Owen, is the largest species, the Dendropetons next, and the Hylonomus wymanii is the smallest. As Dr. Dawson has described these curious animals in the "Canadian Naturalist," in detail, I will not repeat them here, but add a list expressing some peculiarities of dentition, which are highly important in the determination of species. This, giving the number of teeth in a line of 1-12th of an inch, has been furnished me by Prof. Dawson.

HYLONOMUS LYELLII, *Dawson.*

Loc. Cit. VIII., 167, Coal Measures of Nova Scotia.

HYLONOMUS ACIEDENTATUS, *Dawson.*

Loc. Cit. VIII., 258, Coal Measures; with the last.

HYLONOMUS WYMANII, *Dawson.*

Loc. Cit. VIII., 270, Coal Measures; with the last.

	No. of Teeth in Line.
Dendrerpeton acadianum.	
Outer series of teeth,	4 teeth in one line to $1\frac{1}{4}$ line.
Inner do.	4 in $2\frac{1}{2}$ lines.
D. owenii.	
Outer Series,	4 in one line.
Inner do.	4 in two to $2\frac{1}{4}$ lines.
Hylerpeton dawsonii,	4 in five lines.
Hylonomus lyelli,	12 in two lines.
H. wymanii,	12 in $1\frac{1}{2}$ lines.

PARIOSTEGUS, *Cope.*

Proceed. Acad. Nat. Sci. 1868, p. 211.

This genus is represented by a large part of the cranium of a batrachian from the triassic coal measures of Chatham county, North Carolina. If not a batrachian, it could only belong to a Ganoïd fish, but though some of its characters are somewhat ichthyic, it lacks the following important elements of the Ganoid structure, *i. e.* post and suborbital bones; postnareal cavities, branchiostegal, and arched branchihyal bones. On the other hand it has a large preorbital, bounding the frontal and maxillary to the nares, and the inner border of the orbit, as in Stegocephalous Batrachia; also a postorbital element, contributing to the formation of an extended supratemporal roof.

Contrary to what has been found the case in most genera of Stegocephali, the maxillary appears to extend posteriorly to a free termination, as in modern Salamanders, and the supratemporal bone presents a very prominent, obtuse, arched margin. This margin extends from the orbits on each side, and is inclined towards the posterior part of the cranium. There is therefore no quadratojugal piece.

The maxillary and mandibular pieces are slender, flat bones, as in Menopoma; the form of the posterior or articular portion of the latter cannot be ascertained from the specimen. The more or less exposed part of the median region of the latter, exhibits a succession of shallow transverse notches, enclosing thirteen obtuse elevations. The former resemble rudimental lateral alveolae for minute pleurodont teeth. A few other similar minute ribs, and, perhaps, a minute curved cone without sculpture, are the only other indications of dentition.

The bones of the upper surface of the cranium are more readily interpreted by reference to those of Menopoma. A pair of narrow nasals, acuminate behind, penetrate between the frontals as far posteriorly as the posterior margins of the orbits. The suture between these is very distinct, and entirely straight. The preorbitals extend to above the orbit, and then appear to cease with a transverse suture. Between these and the nasals a broad triangular element enters on each side, not attaining the probable position of the nostrils. Each is divided by a longitudinal groove, which is probably a suture, and which would then divide the frontals from the parietals. The frontal would then divide the parietals entirely, as they do in Menopoma, for the anterior half of their length. This would give the frontals a narrow form, acuminate in front, and bounded behind by a regular coarse, zig-zag transverse suture. The cranium behind this point is rugose, and the surface not well preserved, and it can only be said, that two peculiar grooves converge to a point between the posterior extremities of the frontals, like the boundaries of the supraoccipitals. The posterior boundary of the cranium with the condyles cannot be

readily determined. When the postorbital roof bone is raised up, the meeting of two gular dermal bones, as I interpret them, is seen. One of these is a plate directed backwards and outwards, bearing minute radiating lines on its upper surface. It meets a similar flat plate directed forwards and outwards with similar lines radiating to the circumference. The inner margins of these plates were not seen.

The orbits are remarkably small, and situated probably near the middle of the longitudinal measurement of the cranium. The external nares are not defined, but symmetrical depressions in the position they usually occupy in Salamanders are distinct.

The general form recalls Menopoma, particularly the small orbits. A slender curved bone with a slightly dilated and truncate extremity, lying by the cranium in connection with the mandible, is like a branchihyal of that genus. Nevertheless it cannot be positively assigned to that genus, as numerous cycloid scales of fishes are on the same block.

PARIOSTEGUS MYOPS, *Cope.*

The surfaces of the cranial bones are little sculptured; there are small tuberculiform elevations on the parietal and more numerous ones on the preorbitals. The postorbitals show the strongest markings of elongated pits, which radiate to their circumference, leaving a smooth obtuse border. The nasals present a series of small warts at a little distance on each side of their common suture, and transverse to it. The surface of the maxillary is marked with longitudinal grooves and shallow pits.

No suture separating maxillaries and premaxillaries can be traced with certainty, though the bones of the jaw are interrupted at the usual place of suture, opposite the nostril.

Measurements.	*Lines.*
Length of specimen (including mandible),	18
Width between outer convexities postorbitals,	17
Do. do. inner borders orbit,	11
Do. of same without preorbitals,	8
Do. of nasals at middle,	2.5
Do. of orbit,	1.5
Length of frontal and nasal premaxillary,	11
Do. of supposed branchihyal,	12

The name is derived from the roof-like postorbitals with free lateral margin.

LOCALITY.—Coal bed of the Keuper Triassic, Chatham county, North Carolina. The species was discovered by Prof. Jos. Leidy, who handed it to me for description. It is in the Museum of the Academy Nat. Sciences of this city.

DENDRERPETON, *Owen.*

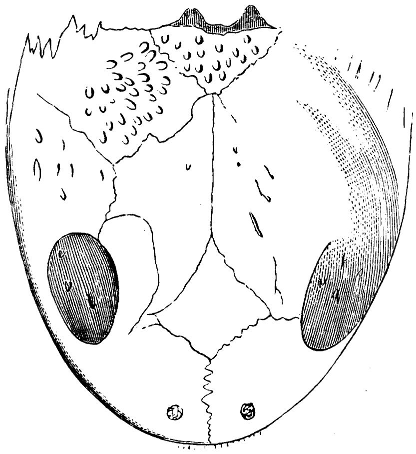
Journal Geological Society, London, 1853, p. 81.

In the form of the cranium this genus differs from Brachydectes and œstocephalus much as Menopoma does from Amphiuma. Two species appear to have left their remains in the coal measures at Linton, Ohio.

There is an internal as well as an external suries of maxillary teeth in this genus, and a vomerine patch, according to Dawson. The skin was ornamented with osseous scales of an oval form, some of which were longer than others, and formed crest-like series along the side. In a specimen of the mandible of the D. acadianum, kindly sent me by Prof. Dawson, the inflection of enamel at the base of the tooth is readily observed, but it appears to be as smooth as in any other type of the Microsauria above the alveolar margin.

DENDRERPETON OBTUSUM, *Cope*

Fig. 1.



This species is known by a partially preserved cranium. The superior surface is exposed, the outlines of the jaws and orbits are well preserved, with the occipital condyles. The os quadratum is directed obliquely backwards, and the angle of the mandible extends to a line a little behind that of the occipital condyles. The zygomatic arch exists in a position similar to that in which it may be seen in a few genera of Anura, as Discoglossus and Pelobates. It extends downwards and forwards from the supra-squamosal to the maxillary region, but whether it is homologically squamosal or malar the specimen cannot show. The postorbital is present as well, and with the last, and the supratemporal, forms the bony roof of the temporal fossa. A piece which may be the pre and post frontals combined, borders the inner superior margin of the orbit, it widens posteriorly, where it has contact with the parietal, etc., and narrows in front. Supraoccipitals form together a broad triangle on the upper plane of the cranium, of less extent than the adjoining supratemporal. These elements are pitted, and towards their margins radiate grooved. These sculpturings grow less on the margins of the supratemporal, and the portions of the surface of the more anterior elements remaining, are so slightly marked as to give the impression that the sculpturing in this species is much less than in others of the genus. A few beaded ridges are all that remain on the parietals and postorbitals; the maxillaries have a slightly stronger sculpture seen in a few spots.

The general form of skull is elongate behind, and much shortened in front of the orbits. The orbits are thus altogether in front of a line equally dividing the cranium transversely, while in the D. acadianum they are in the middle of the skull. The outline of the muzzle in our species is then broad, rounded, as in the Menopoma allegheniensis, while in the latter it is ovate and produced. It therefore resembles also in its proportions the genus Herpetocephalus Huxl, from the Irish Coal Measures.

The parietal bones extend to opposite the posterior margins of the orbits, are then gradually contracted, and form an acuminate prolongation on each side the wedge-shaped frontals. The prefrontals are thickened on each side the front, behind the external nares. The sutures defining the frontals anteriorly, the nasals, and the premaxillaries behind cannot be made out. The median longitudinal suture is a marked and zigzag one, and can be seen as far

posteriorly as the anterior margin of the orbits. The external nostrils are large and opposite the inner margin of the orbit on each side. This separation of the nares is associated with a greater transverse extent of the premaxillaries than in some of the genera. These have been set with numerous teeth, judging by their small impressions; no larger ones have left traces, and no traces of any on the maxillaries. The teeth of the genera before described are all much larger relatively, indicating still further the diversity between them.

A fragment of mandible remains, but without teeth or external surface. It shows a large internal canal.

Measurements.	*Lines.*
Total length cranium,	25.5
Width do. three lines behind orbits,	24
Do. between orbits,	7.5
Do. do. nares,	5
Do. occipital condyles,	2.2
Do. of supraoccipital bones,	6
Do. of right parietal,	6
Extent of premaxillaries,	8.7
Length orbit,	6

From the Coal Measures at Linton, Columbiana county, Ohio. Discovered by Dr. Jno. S. Newberry. When the remainder of the skeleton of this species is known, its generic relations will be better established.

Another cranium accompanies the collection, which belongs to a species distinct from the last. The muzzle is not so broadly rounded and the premaxillary teeth are relatively much larger. The sculpture is more delicate with the ridges more acute. The orbits and nares are not defined. The maxillary is well preserved for a length of an inch; its teeth are smaller than the premaxilliries; I count four in a line; crown simple conic. External surface of maxillary not very strongly sculptured.

This species cannot be referred to its genus without further material. I therefore do not name it.

DENDRERPETON ACADIANUM, *Owen.*

Quart. Journ. Geol. Soc. X., 1853, 81. Dawson, Loc. Cit.
Coal Measures. Joggins, of Nova Scotia.

DENDRERPETON OWENII, *Dawson.*

Canadian Naturalist and Geologist, VIII., 161.
Coal Measures: as the last.

HYLERPETON, *Owen.*

HYLERPETON DAWSONI, *Owen.*

Journ. Geol. Loc. Lond. Loc. Cit. Dawson, Canadian Naturalist and Geologist, VIII., 272.
Carboniferous Coal Measures. The Joggins, Nova Scotia.

BRACHYDECTES, *Cope.*

Proceed. Ac. Nat. Sci., Phila., 1868, 214.

This genus is indicated by two rami of a mandible and a portion of a premaxillary only. These, when compared with those of Œstocephalus, and Dendrerpeton, from the same locality, and with others described by authors, are so much stouter, *i. e.*, shorter and more elevated, that they evidently belonged to a genus not hitherto known. The genus further differs from Oestocephalus, in having the teeth of equal size to the posterior parts of the series, that is, to the base of the elevated coronoid process. The teeth are elongate cylindric cones, with their acute tips turned a little posteriorly. The fractured ones display a large pulp cavity. The three premaxillaries preserved are similar, but without curvature of the tips. They do not exhibit striæ or any other sculpture.

So far as the remains known go, the genus is nearer Hylerpeton than any other. According to Dawson that genus is provided with a large canine-like tooth, at the anterior extremity of the maxillary, on the inner row, which is inserted into a distinct socket. No such tooth appears among those of this genus. The latter does not give any indication of the very elevated coronoid process of Brachydectes, though the external portion of the dentary bone in that region being lost, little can be said about it. Prof. Owen's plate indicates a ramus whose depth at the last tooth enters $8\frac{1}{2}$ times the total length. In our species this depth enters about 5 times.

BRACHYDECTES NEWBERRYI, *Cope.*

This species is represented by one nearly perfect ramus mandibuli, one dentary bone, and one premaxillary, probably not complete.

The dentary bone appears to have been attached by suture to the articular and angular, as its free margin has very much the outline of that suture in Amphiuma and lizards. The coronoid process would also seem to be a part of the same bone as in Amphiuma and Menopoma, and not composed of a coronoid bone as in lizards. It rises immediately behind the last tooth, and displays no suture.

The lower portion of the dentary is prolonged into an acute angle. This is separated by a deep and wide concavity from the superior posterior prolongation, which is obtuse and rises at once into the coronoid process. Teeth on this dentary seven; the same number is on the preserved ramus; this number is suspected to be complete or naerly so. The teeth terminate at the obvious termination of each ramus, which is, it is true, slightly obscured. These teeth are the longest of the Microsauria in relation to the depth of the ramus, equalling the largest in Œstecephalus. They are doubtless exposed, as are some of those of the last named genus, by the splitting away of the outer parapet of the dentary bone. As no traces of alveoli have been thus rendered visible, I suspect the dentition to have been acrodont, as in some existing Batrachia.

No external surface of the mandible remains, but there are no impressions of sculpture on the matrix. A little external face of the premaxillary displays none.

Measurements.	*Lines.*
Preserved length of ramus (imperfect),	11
Depth at last tooth,	2
Length of exposed tooth,	1.7
Length dentary,	7.5
Depth at coronoid,	3.5
Do. at first tooth,	1.3

In the mandibular ramus of the Hylerpeton dawsoni, there are according to Owen at least nine teeth; in the present species there are but seven.

SAUROPLEURA, *Cope.*

Proceed. Acad. Nat. Sci. Phil. 1868, p. 215.

This genus embraces a single species only, as I at present understand it. The extremities are well developed, and the body is stout and lizard-like. It is represented by but one individual which has been spread over a surface of the coal slate, exhibiting ventral armature, dorsal region with ribs, and anterior and posterior limbs. Of skull and caudal vertebræ nothing remains.

The dermal riblets are arranged as in Urocordylus, *i. e.* in parallel lines directed obliquely forwards and continuous on the median line, forming there a chevron directed forwards. The striæ are not so closely placed as in O. pectinata, but are separated by grooves wider than themselves.

The humerus, ulna and radius, are rather stout, and of a size relative to the body, as in common types of existing sauria; the ulna and radius separate. There is no carpus, but five well developed digits have phalanges in the following numbers, commencing on the inside, 3, 4, 5, 6, 5. The last phalange of the second is obscured, and it is not positive that the number is as given; it is more probable than that it should have been 3. The outer toe has been more slender than the others; the distal phalanges of all the toes are short conic, as in Salamanders. Thus this form differs much from Amphibamus, where the numbers are 3, 3, 4, 5, 4, showing a lower development of limbs.

The ribs are long and curved as in Reptiles, and judging by their distances the vertebræ are short; the latter are not well defined but there is no indication of prominent spines of any kind.

The pelvic bones and portions of those of the hind limbs are present, but so obscured and confused as not to be made out. Enough remains to show that the hind limbs are considerably longer than the anterior.

SAUROPLEURA DIGITATA, *Cope.*

Proc. Acad. Nat. Sci. Philadelphia, 1868. 216.

This species had a length of body about equal to that of a fully grown Chamæleo vulgaris of the largest size or of a half-grown Menopoma. Thirteen ribs on one, and several on the other side, are preserved; where they terminate, probably at the pelvic region, some small or rudimental ribs project from the two or three first caudals. Three ribs and their interspaces extend over five lines. The humerus is broken, but its length can be clearly made out to be seven lines; it has no condyle, and is dilated at both extremities. The ulna and radius are distinct, truncate, hollow, and dilated at the ends. Length of ulna 5.1 lines, distal width 1.8 lines. Carpus not ossified. The fourth toe is considerably longer than the others, the fifth is next and reaches the basal third of the antepenult phalange of the fourth; the third is very little shorter; the first is not quite so long as the first two of the third. The bones of the hind limb are not readily distinguished. They are evidently much longer and larger than the anterior; no part of a foot is preserved.

This form is probably allied to Urocordylus. It has relatively much stronger ribs in relation to the vertebræ than we have seen in that genus, and there is no evidence of the existence of the vertebræ characterizing the latter. The limbs are relatively much stronger than in Œstocephalus, and it lacks the peculiar dermal armature of that genus.

ŒSTOCEPHALUS, *Cope.*

Proceed. Acad. Nat. Sci. Phila., 1868. 218.

This genus is represented by a more complete series of remains than any other of the Linton bed.

As before remarked, it represents in many respects, the Ophiderpeton of Huxley, and has been alluded to by Dr. Newberry as allied to it. It however, differs markedly in the narrow lanceolate form of the head, with probable accompanying peculiarities of detail, and in the presence of limbs, which have not been found in the Irish genus. The form of the head is somewhat nearer that of Lepterpeton Huxl., but the remarkable form of the spines of the caudal vertebræ so characteristic of the American genus, are not found in Lepterpeton. In this latter respect it is allied to the Urocordylus of Huxley, recently discovered in the Coal Measures in Leinster, Ireland. It differs only in the presence of elongate lizard-like ribs and in the absence of "oat shaped scales" of the lower surfaces.

It is a matter of much interest in American Palæontology that this remarkable type should be found to occur in our Coal Measures. It was first announced by Dr. Newberry at the meeting of the American Association for the Advancement of Science for 1867. (See p. 144), as an ally of Urocordylus and Ophiderpeton.

The forms discovered by Dr. Newberry have an interesting relation to those of Ireland, such as types of the present period frequently present.

The characters of Oestocephalus are: neural and hæmal elements of the caudal vertebræ, elongate, distally, dilated and grooved, attached by contracted bases. Ventral aspect defended by a close series of oblique dermal rods on each side, which meet anterior-

ly on the median line. Limbs distinctly developed. Ribs long, well developed. Scales none.

In more detail, we have an elongate lanceolate head with little or no sculpture of the external surface of the bones. The angles of the mandibles are much prolonged backwards as in Apateon and frogs, and the well developed ribs commence but a short distance behind the head. The vertebræ are slender, and furnished with well developed diapophyses.

The neural spines of dorsal vertebræ in O. remex are flattened and expanded in the line of the vertebral column, and weakly grooved to their superior margin. Their character has not been observed in the other species.

The neural and haemal spines of the caudal vertebræ are prolonged, and remarkably sculptured by longitudinal grooves, which are most distinct towards their terminations. They are much flattened to support an oar-like tail.

Anterior limbs have been seen in two species, and posterior in one other. Though they all probably possess two pairs of limbs, this point is not entirely established, leaving the homogeneity of this genus still somewhat uncertain.

A pair of symmetrical bones whose impressions are seen posterior to the occipital bone appear to be the coracoid, and one of them is followed by a second element, which is probably the humerus. A third piece follows, which is ulna, or radius; the second bone of the forearm is lost, but some impressions, which appear to be those of a digit, are visible.

The skin has been occupied by a great number of closely packed, curved, spine-shaped scales. They have occupied the ventral integument, passing from the median line of the belly outwards and posteriorly, having acute tips which may or not have penetrated the skin on each side. No such tegumentary spines protected the dorsal region.

The three sculptured dermothoracic plates common to so many of this order, have not been seen in this genus.

As compared with Sauropleura, this genus is more elongate and snake-like, and with much weaker limbs; these characters are not sufficient to distinguish it alone, but as no dilated neural spines nor similar abdominal armature are discoverable in the former, I prefer to keep them separate for the present.

OESTOCEPHALUS REMEX, *Cope.*

Sauropleura remex, Cope. Proc. Ac. Nat. Sci., Philada., 1868, p. 217. *Oestocephalus amphiuminus*, Cope, l. c. p. 218.

Additional specimens received from Dr. Newberry enable me to combine the caudal vertebræ described as above under the genus Sauropleura, with the remainder of the skel-

eton which was the type of the present genus. The species thus constituted is represented by five specimens and their reverses, and a fifth may be added with much probability.

They indicate an animal of the average size of the Amphiuma means.

The extremities of the vertebræ are deeply concave, but the centra are so long as to prevent the concavities entering more than one-fifth of the latter, each. The diapophyses are behind the middle, and are broad, curved backwards, and acuminate as in Amphiuma. The centra have a prominent median line below, with a longitudinal concavity on each side. Five of them a little exceed an inch in length. Neural spines moderate. The humerus is longer than the coracoid, and is considerably dilated distally; the coracoid slightly dilated at its superior extremity. The dermal armature commences immediately behind the head, and forms a band of 14 lines in width; measuring across the spine-like scales, in a width of a line, four cylinders may be counted. The external portions are curved backwards, the interior nearly straight, those of the anterior series more delicate than the posterior.

The head is wedge-shaped, with regularly acuminate sides. The top of the cranium is somewhat broken in the specimen; the portions preserved are smooth, and the longitudinal suture is distinct for a considerable distance. The angle of the mandible is produced considerably behind the occiput, and is enlarged and rounded. The end of the muzzle is broken away, and the region of the orbits so fractured as to render their precise location uncertain. The superficial layer of the cranial bones is nowhere clearly visible, so that it cannot be ascertained whether it is sculptured or not. The quadrate bone projects well posteriorly. Some fragments indicate small cylindric teeth, as in Amphibamus, but they are not characteristic.

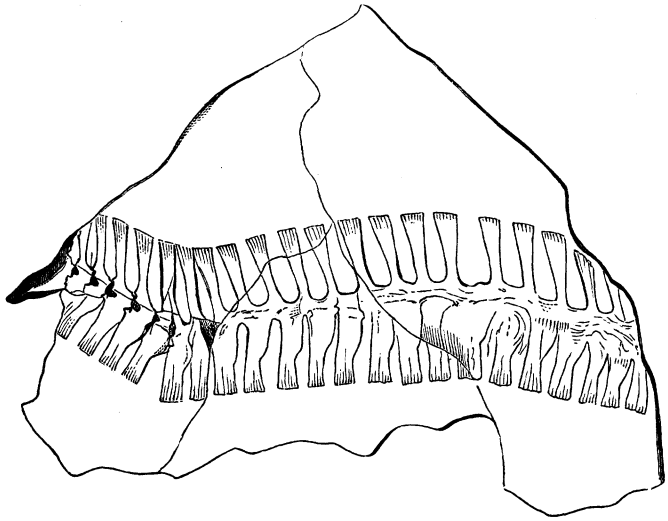
Measurements.	*Lines.*
Length cranium without muzzle,	17.3
Width do posteriorly,	11.5
Length of the coracoid,	2.1
Length humerus,	2.5
Length of sixth vertebra from skull,	3
Extent diapophyses,	3.5
Width centrum,	1.5

The characters of the genus are further shown by a part of another individual in the same coal slate matrix. The cranium and anterior portion of the vertebral column only are preserved, the latter so much injured as to render the vertebral characters very obscure. As in the other, the bristle-like scales extend along the dorsal region to near the cranium. The anterior $\frac{2}{3}$ of the ventral side shows a large number of oval scale-like bodies, which belonged undoubtedly to the animal, and were probably dermal scales. They are, however, neither regular in from nor position. Close behind the head two or three long bones of the fore limbs have been exposed. They are slender and similar to those of the last specimen.

The cranium, though without the muzzle, shows its long wedge shape. The maxillary bone cannot be distinguished, nor can the orbits be made out. One ramus mandibuli is pretty well preserved; it shows no coronoid process. Thirty-one teeth may be counted on a portion a little more than one-third its length. The anterior eleven of these are abruptly longer and stouter than the others. They are all, except a few most anterior, in pairs, *i. e.*, with a slight vacancy between every two. The larger ones where broken at the bases exhibit a moderate pulp cavity; the smaller, a large one extending to near the lip. Several, though not all of the larger teeth, display a shallow groove on the external face to near the tip, which is probably owing to pressure and a partial crushing. The points of the larger teeth are more abruptly acute, and turned abruptly backwards. A portion of their increased length (.35) is to be attributed to the splitting off of the external dentary margin, and the exposure of the roots. No alveoli are shown, and the dentition is probably by anchylosis of expanded base as in true Labyrinthodonts.

A third series, Nos. 26, 29, Mus. Newberry, of dorsal vertebræ is without head or limbs. The vertebræ are elongate, three of them extending over 2.10 mm. The neural spines are longer than high, and are nearly in contact at their margins; each is marked by about five obtuse vertical ribs. A fractured section of the abdominal dermal spines in place, displays at least six superimposed layers of them.

Fig. 2.



CAUDAL VERTEBRÆ, NAT. SIZE.

This species is larger than the O. pectinatus, and about equal to the Urocordylus wandesfordii Huxl. The caudal spines differ in the greater attenuation of the neural series, and the presence of a basal lamina on the haemal. The caudal region is represented by a portion of the vertebral column three inches in length. In this space may be counted twenty-four vertebræ. Such of the latter whose outlines are visible, display centra characteristic of the genus; their terminal concavities conic, with apices meeting in the centrum, medially; zygapophyses rudimental if present.

Characteristic of the species are the remarkable length and slenderness of the fan-shaped neural and haemal spines, and the absence of an acute serration on their margins. In this species the spines have a laminiform expansion at the base in their plane. In the other species here described these spines are not only relatively broader and more fan-shaped, but they are acutely serrate on the margin and constricted at the base.

In C. remex the dilate haemal spines are a little more than three times as broad distally, as they are long, while the neural spines are a little narrower. The haemal spines stand about the middle of the centrum. The basal half is furnished with an anterior ala, which leaves the anterior margin rather abruptly and extends to the next spine in advance. It returns gradually to the centrum and is separated from the articular face of the latter by a notch. A similar ala exists on the posterior margin of the haemal spine, which extends for a shorter distance above the base, and is narrower than the anterior. Each spine presents a median groove on its surface, which extends half way to the base or further; on each side of this are some three other grooves which extend but a short distance; surface otherwise smooth. The ends of the grooves slightly notch the truncated end of the spine.

The neural spines are on the posterior portions of the centra, and not in contact with the bases of those adjacent. They are without the dilatations of the haemal spines, and are directed rather more obliquely backwards. They are similarly grooved, though without that so distinctly median, seen in the haemal series.

Both neural and haemal spines become stronger towards the anterior part of the vertebral column. There appear to be no zygapophyses nor diapophyses, nor rudiments of ribs. The centra are rather stout and somewhat constricted medially. There are no traces of dermal armature of any kind.

Measurements.	*Lines.*
Length of a posterior centrum,	1.2
Depth do. do. do.	1
Length haemal spine of adjoining vert.,	4.4
Basal width,	1.4
Median width,	.9
Distal width,	1.1
Length of a more anterior haemal spine,	4.3
Distal width do. do. do.,	1.5
Length anterior neural spine,	4
Width do. do.	1.4

From the Coal Measures, the Bituminous basin at Linton, Columbiana County, Ohio, near the Ohio River. Prof. J. S. Newberry.

ŒSTOCEPHALUS PECTINATUS, *Cope.*

Sauropleura pectinata, Cope, loc. cit., 1868, 218.

This species is represented by portions of the vertebral columns of four individuals. In two of these, vertebral centra are discoverable, in one quite definitely. They are slightly constricted medially, and without ridge or process.

The neural and haemal spines of superior and inferior lines are similar, and in the specimens undistinguishable. The dilated portions form nearly equilateral triangles, which stand on moderately short pedicels. They are weakly ridged, and each ridge is prolonged into a narrow acute tooth, beyond the margin of which eleven may be counted on one of the best preserved. The longitudinal striae are terminated near the pedicel by two others which cross obliquely from each side and meeting present an appearance similar to an overlapping of each margin. The edges of the spines form a continuous line.

As in the other species, there are no indications of other processes, nor of dermal scales.

The smallest of the specimens shows that in front of the region furnished with the peculiar spines described, the body is furnished with a mass of bristle or hair-like scales. The grooved neural spines are slightly displaced anteriorly, and the bristle-like mass looks like a continuation of their striae, and it is not easy to find any line of demarkation between them. The serrate spines are further forwards on one side than the other. These linear scales were arranged as in other genera, in lines which converge forwards to the median line. They are somewhat obscured in the specimen, but it cannot be determined that they are continuous on the median line. Whether this is the posterior or anterior portion of the body cannot positively be determined from the specimen; it is, however, most likely the posterior, for near the posterior portion of the striate surface a weak pair of limbs is given off on each side. On the right, a moderately stout femur is followed by a broken tibia and fibula, and by five slender, closely oppressed metatarsals. The last are about 2-5 as long as the space between them and the femur: beyond them a few slender phalanges are moderately distinctly defined. The tibia is more distinct on the left, but no tarsus or phalanges; some of the metatarsals are preserved here also. Length of limb to end of metatarsals equal to five vertebræ in juxtaposition, measured along the edges of the neural spines. The limb has been slender, especially the hand.

The above specimen enables me to assign as the ventral armature of this species a closely packed series of V-shaped grooves which lie in connection with an obscure vertebral column, on the block containing one of the typical specimens of this species. They are not continuous with any of the series exhibited on other parts of the block: some of these at least are the doublings of the slender animal, and this ventral portion has been displaced. The grooves are like the impressions of haemapophysial rods, vastly more numerous however than the number of vertebræ; they are really the dermal armature. Huxley figures a portion of this as on the block with the Urocordylus wandesfordii, but does not refer it to a precise relation to the animal. A few well developed ribs are preserved with this portion, the only ones I can refer to this species. The vertebræ are partly enclosed in matrix, partly impressions. The neural spines, though expanded anteroposteriorly, are less elevated than in the caudal region, and have left no traces of their characteristic ribs or serration.

The number of spines in the type specimens is six in a half inch; in the smallest, just described, ten in the same distance. The height of the spine in the former 1.15 lines.

MOLGOPHIS, *Cope.*

Loc. Cit. 1868, 220.

This genus is established on remains represented by three specimens, which are two series of dorsal vertebræ with ribs, and a series of caudals. One of the dorsal series embraces sixteen vertebræ, the other fourteen, the caudal series, twenty-two.

From its serpentine form this genus may be compared with the Dolichosoma of Huxley, though a close relation does not exist between them. In the Irish genus, the

series of caudal vertebræ is quite short, and the ribs are short and but little curved. In Molgophis the tail has been like that of an elongate serpent, and the ribs are as well developed as those of many reptiles.

Though no limbs or arches can be certainly found, a rather quadrate, parallelogrammic piece, about as long as the diameter of a vertebra, may be found. This is however very doubtful.

The characters of the genus are: a long serpentine body, without dermal armature, so far as discoverable; the vertebræ large and broad with very prominent zygapophyses and moderate neural spine, those of the caudals without narrowed bases (and grooved or serrate edges, most probably). Limbs and cranium unknown.

This genus differs from Urocordylus in its caudal vertebræ, and from Ophiderpeton in its dorsals: the latter in their zygapophyses projecting laterally resemble those of Amphiuma. It differs from Œstocephalus in the absence of ventral dermal bands and in the longer body, without indication of limbs. The size of the vertebræ would indicate a body of the size of a rattlesnake, (*C. horrida*,) and therefore too large for the species named Brachydectes *newberryi*.

The ribs are long, and though the head is not bifurcate, there appear to be both tubercle and head on the dilated extremity. They show themselves where crushed to have a large median vacuity.

MOLGOPHIS MACRURUS, *Cope*.

The neural arches viewed from above have a posterior V-shaped outline, from the fact that the broad zygapophyses meet on the median line, and spread out distally over the broad anterior ones adjoining. The latter appear to be somewhat concave, and to border the former exteriorly as well as inferiorly. The base of the neural spine extends to the posterior emargination, but not quite to the anterior. The breadth of the dorsal vertebra above is equal from the emargination behind to the anterior margin of the anterior zygapophysis.

The caudal series must have been very long, as there is very little diminution in the size of the vertebræ throughout the series preserved. They present much the same form as the dorsals, but are more contracted medially, and the zygapophyses have a more transverse direction. There may indeed be a diapophysial element beneath these, but the two cannot be distinguished if so. They are connected by longitudial impressions, indicating the existence of the tendinous bands in the longitudinal muscles seen in Amphiunna, or the osseous spicules in the same situation in birds. The neural spines indicated by their narrow bases, occupied the length of the neural arch, and remind one of Amphiuma.

The ribs are long for a Batrachian, but shorter than in a reptile. They are well curved, chiefly near the proximal extremity. The longest I can find measured by a chord, equals two vertebræ and two-fifths. Three vertebræ measured along the median line above equal eleven lines; one of these is 3.6 lines in width above; width of a (?) posterior caudal 3 l.

This animal has been like Amphiuma a snake-like Batrachian, but probably of even more elongate form. How near its affinities to this genus may be, cannot be ascertained, owing to want of important parts of the skeleton, but it differs in the important feature of the large, well developed ribs.

GANOCEPHALA.*

COLOSTEUS, *Cope.*

This genus is proposed for Ganocephala, allied to Apateon (*Archegosaurus*) but differing as follows:

There are no traces of vertebral centra or spines, or of ribs, in portions of six individuals preserved. No sclerotic bones can be found in one cranium partially preserved. There appears to be two pairs of very short limbs. The usual three sculptured pectoral bones are present, consisting of a rhombic medial, and a pair of half rhomboid laterals. The abdominal region is protected by series of scales which extend obliquely forwards to the medial line, where they meet, forming chevrons. They are closely approximated, and are composed of rhomboidal scales which have a convex external and internal face, in transverse section, and which overlap at the extremities, and are in contact by faces which are oblique in both the longitudinal and transverse directions.

The exact form of the muzzle cannot be made out. It is, however, not elongate, nor yet of the broad rounded form of Pelion. Several teeth are preserved. There are two kinds, which occupy the margins of the maxillary and dentary bones. The anterior teeth appear to be longer than the posterior, though the latter are mostly broken off. Most of the teeth are coarsely incised sulcate for perhaps their basal half. Two long teeth behind their distal extremity of the dentale, are on the other hand very finely and sharply striate for their basal half; the tip is subcylindric, and very prolonged and acute. A small, dagger-shaped tooth near the base of one of the posterior, may belong to the successional, or to a small outer series. A series, of four elevated tooth bases, with a broken crown, of much smaller size than those of the jaws belongs to the vomerine or a palatine series. The row is single and uniform.

The superior face of the cranium is injured, but the component bones appear to have possessed a radiating sculpture of no great distinctness.

The form of the body seems to have been long and fish-like, with little contraction near the limbs. Caudal extremity is not preserved. There were probably two pairs of very weak limbs, of which three metacarpals of the anterior are preserved. A narrow longitudinal bone extends posteriorly from the lateral pectoral bone. Its extremity is broken, but a flat, narrow, longitudinal bone, with a dilated extremity curved outwards, may belong to it, or be the humerus. I find no distinct traces of branchial arches.

The affinities are thus obviously to Apateon, and it is not beyond possibility that future investigations may prove it is the same, though this is not probable at present.

Portions of seven individuals of one species, and of one individual of another, were discovered by Prof. John S. Newberry at Linton, Ohio. They differ as follows:

Pectoral bones with strong elevated radii and very weak reticulation in the centre of the median. The abdominal scales thick, many in a transverse series.

C. CRASSISCUTATUS.

Pectoral bones nearly as above; the abdominal scales slender, not more than three in a lateral transverse series.

C. MARSHII.

Pectoral bones—the lateral finely pitted, the pits becoming elongate towards the margin.

C. FOVEATUS.

COLOSTEUS CRASSISCUTATUS, *Cope.*

One of the specimens of this species consists of a supero-lateral view of a crushed cranium and anterior part of the body. The median pectoral bone appears as a sagittiform plate with thin edges, rounded lateral angles and a thin median prolongation behind. The greater part of the borders of the right orbit are distinct, and display the continuity of the malar and supratemporal regions. The ramus mandibuli is longer than the cranium proper. The number of the teeth cannot be determined, but they are rather large, and traces of their existence do not extend behind the orbits. The length of the long anterior mandibular tooth is .5mm., and the diameter at the base .1mm. Diameter of base of a superior maxillary .2mm. The approximate length of the mandibular ramus is .0715m. long; longitudinal diameter of the orbit 72mm.; length of median pectoral plate .036m.; width of same .019m.

Other specimens (Nos. 4 and 10 coll. J. S. Newberry) show that the abdominal scutellation commences immediately behind the pectoral bones. Those near the median line are similar to the external, and they unite in a zigzag line. The depth of these scales is oblique, and is somewhat greater than the width. Thus one angle projects, and gives the surface a somewhat ribbed rather than continuous character. The following measurements express their dimensions relative to other portions of the body.

	M.
Width of median pectoral,	.0138
Do. three pectorals restored,	.054
Do. scale band,	.064
Scales in .01m. transversely to series,	5.2
Do. longitudinally do.,	1.75
Radii of lateral pectoral crossed by .01m.,	7
Length ulna and radius,	.0108
Do. metacarpus,	.006

The above measurements express the small size and weakness of the fore limb. Another specimen (No. 18) in which the impressions of the scales are of the same size as those of the preceding, the impression of what may be femur and ulna and radius are visible, which are of considerably smaller size than the one above mentioned. They are but doubtfully these elements.

	M.
Length proximal element,	.004
Do. two distal do.,	.0038

A median pectoral plate of a seventh and much larger individual than the preceding is prolonged anteriorly and posteriorly. The broad posterior portion is transversely ribbed, the ribs weaker and interrupted medially. Length .063m.; with .04m.

This very interesting form is part of the unique and important collection made by Prof. J. S. Newberry, at Linton, Columbiana County, Ohio.

COLOSTEUS FOVEATUS, *Cope.*

A very elegant sculptured median pectoral plate represents this Batrachian. It is larger than most of those of C. radiatus, but smaller than the one last described. The posterior and median parts of the plate are pitted to the number of six in five mm. The pits are separated by sharply defined ridges. They elongate towards the anterior parts of the plate, resembling elongate hexagons, and the ridges approaching radii, though not more elevated than the cross septa. The bevelled margins are rugose also, except at the edges.

	M.
Length of the bone,	.045
Greatest width,	.025
Width posterior margin,	.021

From Linton, Columbiana County, Ohio. Prof. J. S. Newberry, Coll. No. 20.

COLOSTEUS MARSHII, *Cope.*

Sp. nov.

This species is represented by a specimen of very much smaller size than either of the preceding. That it is not the young of C. crassiscutatus is indicated by the peculiar form of the dermal ventral scales, and by the greater anterior prolongation of the median ventral dermal bone.

The specimen is lying on its back, displaying the ventral armature somewhat disturbed, and broken through in some places, where the vertebræ and ribs would be discerned if they existed. The head is turned abruptly to one side, and is apparently right side up. Several of its elements are scattered on adjacent portions of the block.

The head is of an elongate lanceolate form. The upper surface of the frontal bones is punctate-rugose in relief, with short radii towards the margin. The distal two-thirds of the mandible is narrow wedge-shaped; the external surface is coarsely pitted. There are no teeth preserved. The sutures of the cranial bones are of the squamosal type or fish-like.

The three thoracic shields are considerably displaced. The lateral are subtriangular, and are strongly ridged towards the inner margin. The median shield is short spatulate, the narrow portion directed anteriorly; the posterior rounded. It is coarsely pitted medially, and coarsely and strongly radiate ridged to the margin. Immediately behind these plates the dermal armature commences. It consists of elongate, narrow, subcylindric scales, which are arranged end to end, in series which meet on the median line, converging anteriorly, as in the other types here described. At first sight they resemble the long rod-like pieces of Œstocephalus, and careful examination is needed to detect the interruptions caused by the sutures of the scales. The latter are several times as long as wide, and appear to be terminated by oblique faces as in the typical species.

The trace of limbs is only seen in a short impression resembling that of a humerus behind the thoracic buckler. Nothing can be found pertaining to posterior limbs, but some laminae and impressions in the position of pelvis, but not immediately connected with the other portions of the skeleton, may belong to the latter arch.

Measurements.	*MM.*
Length of body to buckler,	4.2
Width of ventral armature,	.8
Impression of humerus, (or coracoid,)	.2
Length median thoracic plate,	1·15
Width " " "	.51
Length fragment under jaw,	.75
Depth do. at middle,	.15
Width end muzzle,	.29

This species, like the preceding, is from Dr. Newberry's collection, (No. 13,) and from the Linton coal bed, Southeastern Ohio. I have dedicated it to Prof. Othniel C. Marsh, Professor of Palæontology in Yale College, Connecticut.

LABYRINTHODONTIA.*

DICTYOCEPHALUS, *Leidy.*

DICTYOCEPHALUS ELEGANS, *Leidy.*

Proc. Ac. Nat. Sci., 1856, 256, Emmons' Geology Nor. Amer. p 59. Tab.
Triassic Coal Beds, Chatham County, North Carolina.

BAPHETES, *Owen.*

BAPHETES PLANICEPS, *Owen.*

Quart. Journ. Geol. Soc. Lond., X., 1853, Tab. (XI notes.)
Carboniferous Coal Measures of the Joggins, Nova Scotia.

EUPELOR, *Cope.*

EUPELOR DURUS, *Cope.*

Mastodonsaurus durus, Cope. Proc. Acad. Nat. Sci. Philadelphia, 1866. 249.

A portion of the table of the cranium of a large labyrinthodont accompanied other fragments of the same in a bed of hard black shale, according to Wheatley's section of the Trias at Phœnixville, Pa., (in Silliman's Journal Sci. Arts, 1861, 45.) about 181 feet from the top of the series, while a tooth formerly described with it is from near 83 feet higher, in "the Plant bed." The Belodon comes from the same as the last.

The largest fragment is eight inches long and eight and one-half wide, and is a portion of the table of the cranium exhibiting the usual medial depression and embracing portions of the postorbital and parietal bones; one of the former is four inches six lines long; both are pitted medially (about 3½ pits in an inch) and marked with short coarse sulci posteriorly. The parietals are two inches nine lines wide behind, and four inches wide between the anterior parts of the postorbitals. On what is probably the posterior part of the interorbital region (a small part of the posterior margin of the left orbit is preserved) commence two smooth, shallow sulci 1 in. 2 l. apart, which are probably the posterior extremities of the superficial channels of the face of the Labyrinthodonts. Between them the surface is pitted (four or five to the inch). The parietal bones are throughout longitudinally sulcate (four and one-half to the inch), with obtuse ridges between. The parietal fontanelle was not discoverable, nor could the form of the orbits be certainly determined, though they were probably not large.

From the Triassic Red Sandstone near Phœnixville, Chester County, Penna. Discovered by Charles M. Wheatley.

Teeth subcylindric, with large pulp cavity at the basis only: external surface without grooves; dentine divided by numerous flat vertical laminæ of a dense substance, probably enamel, which radiate from very near the pulp cavity to the external enamel layer.

I have been much puzzled with the teeth which I described (*l. c.*) in the above language, as typical of this genus. Their constitution has been chemically altered, and the section exhibits the radii of a denser material which unites at right angles with a sheath of the same substance which envelopes the tooth externally.

The teeth are of various sizes, sometimes two inches long and more slender in proportion to the length than those of the Mastodonsaurus jægeri and salamandroides; they are cylindrical, gently curved and acuminate without external sulci: of the minute sculpture little can be said, but the casts of the surface are smooth. The roots exhibit a short conic pulp cavity. In a few weathered sections the denser radii are well displayed.

They are not convolute as in Labyrinthodonts, but perfectly straight and convergent to a minute central vacuity. In a tooth four lines in diameter there appear to be five principal radii, which though exceedingly delicate may sometimes be seen in longitudinally fractured specimens.

*The *Centemodon sulcatus* Lea which I referred here in my synopsis of Extinct Batrachia, Proceed. Acad. Nat. Sci., 1868, may be placed among the Thecodonts. I was induced to place it here by Lea's ascription of sulci and pulp cavity to the tooth, which I did not understand properly.

These I suspected to indicate the positions of inflections of enamel, as it is difficult to imagine such regularly radiating fractures. I cannot however, be entirely sure that this is the case. Under a low power neither the radii nor interspaces exhibit any structure; the small pulp cavity is filled with the sandstone matrix in which the tooth is enclosed. It may be supposed that the relatively denser structure of the enamel has been preserved in the slow alteration which the composition of the tooth has undergone. They thus project on weathered or ground surfaces.

The species to which these teeth pertain was originally described by the writer as a Mastodonsaurus. The latter genus however exhibits external grooves where the inflections of enamel enter and separate the dentine. These inflections, as is well known from the figures and descriptions of Professor Owen, are more or less convoluted, some of them very highly so. The laminæ of the teeth of the Eupelor cannot be looked upon as inflections of enamel, but rather as branches. They are exceedingly thin, and our sections do not demonstrate them to be double. If they are double, they are very much more attenuated than the external enamel stratum. They may be distinguished in a section of the wall of the pulp cavity at the base of the root as well as elsewhere.

The fluted tooth referred to in my original description, in which this structure is observable, belongs apparently to a Thecodont, perhaps to Belodon: other teeth of this genus which I have seen present the same peculiarity. As the tooth from which the description of Eupelor was derived, is from the same stratum as the Belodon and Clepsysaurus, and some distance above the horizon of the cranial bones described, after an examination of the series in possession of Wheatley, I am disposed to refer all these teeth to the Thecodonts, and restrict the name Eupelor durus m. to the cranial bones only.

Class II.—REPTILIA.

The following preliminary table exhibits the more essential characters of the orders of Reptilia, as understood by the writer:*

I. Supratemporal and postorbital bones present; extremital portions of limbs not differentiated; quadrate bone united by sutures.

ICHTHYOPTERYGIA.

II. No supratemporal or postorbital bones; extremital portions of limbs differentiated.

A The quadrate bone united by suture to the proötic, the opisthotic and the quadratojugal bones.

a The scapular arch continuous, including the sternum, which is anterior and simple.

ARCHOSAURIA.

aa Scapular arch not continuous, sternum inferior, extending posteriorly, composed of at least eight elements: dorsal vertebræ sacrum-like.

TESTUDINATA.

AA The quadrate bone not united with the proötic, and articulating freely with the opisthotic; no quadratojugal. (Streptostylica.)

Sacrum from three to five vertebræ; anterior extremities excessively elongated for flight; acetabulum complete; pubes longitudinal, distinct; exoccipital not distinct.

PTEROSAURIA.

* Many of these groups correspond with those proposed by Prof. Owen.

Opisthotic united with exoccipital; brain case not closed before proötics; palatines united all round; sacrum of two or one vertebra; pubes transverse.

LACERTILIA.

Opisthotic distinct and distally free from the cranium; brain case partly closed before proötic, palatines united.

PYTHONOMORPHA.

Opisthotic distinct, free from cranium except proximally; brain case nearly closed anteriorly, palatines attached behind only.

OPHIDIA.

ICHTHYOPTERYGIA.

Elements of the limbs beyond the humerus not differentiated, in indefinite number.
Postorbital and supertympanic bones over the temporal fossa.
Quadratum solidly united by suture with the proötic opisthotic and quadratojugal.
Sacrum none.
Pubes and ischia transverse and in contact. Neural arches free.
Premaxillary divided.

ARCHOSAURIA.

Elements of the limbs, of the pes and manus differentiated, in definite number.
" Postorbitals and supratemporals " of Owen wanting.
Quadratum immoveably united by suture with opisthotic, proötic and quadratojugal.
Sacrum of from one to six vertebræ.
Neural arches attached by suture in most.
Premaxillary divided.
Cranial walls cartilaginous anteriorly.
Palatine bones in contact with maxilliaries, and united by suture with them.
Circulatory System (known only in the Crocodilia). Heart with complete septum of the ventricles; a communication between aorta roots.
Nervous System (known only in the Crocodilia). Cerebellum with small lateral lobes and weak plicae.

TESTUDINATA.

Parts of limbs differentiated.
Dorsal vertebræ without mobility: no clavicle, a procoracoid continuous with scapula: ilium vertical, acetabulum complete.
Sternum not in connection with coracoid, composed at least of eight or more bilateral elements, and extending posteriorly to beneath the pelvis.

Teeth none.

Quadratum immoveably fixed by articulation with the large pro and opisthotics.

Cranial cavity not ossified anteriorly; no ali or orbitosphenoid.

Palatine bones attached anteriorly.

No postorbital or supratemporal elements.

Two sacral vertebræ: ischia and pubes more or less transverse, the latter sometimes not in contact.

Costal and vertebral elements usually united into a dorsal shield: dorsal corium ossified.

Circulatory and Nervous Systems, much as in Lacertilia.

PTEROSAURIA.

Limbs differentiated, one digit excessively elongated for aerial progression.

Postorbital and supratempoial roof wanting.

Sacrum of from three to five vertebræ.

Inferior pelvic elements distinct, the pubes set parallel, directed forwards and not joined.

Neural arches consolidated.

Palatine elements united; one premaxillary.

LACERTILIA.

The distal parts of limbs differentiated; no supratemporal or postorbital bones.

Quadratum not in contact with proötic, articulating freely with opisthotic; no quadrato-jugal.

Opisthotic sessile not distinct.

Sternum composed of but two elements, which are continuous with remainder of scapular arch.

Cranial cavity not ossified anteriorly to proötic.

Palatine bones solidly attached to maxillæ; a symphysis mandibuli.

Squamosal usually present; premaxillary usually single.

Limbs ambulatory, when present.

Sacrum of two vertebræ, when present; ribs single headed.

Neural arches not united by suture, chevron bones present.

Pubes and ischia transverse, united in pairs.

Circulatory System. Heart with imperfect septum atriorum, no communication between aorta roots.

Nervous System. Cerebellum without lateral lobes or plicae.

PYTHONOMORPHA.

Characters of skeleton as the preceding, except: opisthotic distinct, prolonged from the cranial walls as suspensorium of the quadratum.

No symphysis mandibuli.

Squamosal present; premaxilliary single.

Cranium with alisphenoid and parietal developed in front of proötic.

Limbs inflexible, natatory; sacrum none; chevron bones.

Neural arches not attached to centrum by suture.

Pubes and ischia wanting. (?)

OPHIDIA.

Characters of Lacertilia except: opisthotic free, distinct from the cranium except proximally, supporting quadratum; no squamosal.

Cranial cavity largely ossified anteriorly.

Palatine bones free from other elements except pterygoids.

No symphysis mandibuli.

Sternal and pelvic arches wanting; no limbs except rarely rudiments posteriorly; no sacrum.

Vertebræ united by double articulation; neural arches continuous with centra; no chevron bones.

Circulatory and Nervous Systems, in important features as Lacertilia.

ICHTHYOPTERYGIA.

ICHTHYOSAURUS, *Conybeare.*

Leidy says with reference to the species here described, "They have an affinity to *Ichthyosaurus* and *Eosaurus*, nor am I prepared to prove that they do not belong to one of these."

ICHTHYOSAURUS GRANDIS, *Leidy.*

Chonespondylus grandis, Leidy. Proc. Acad. Nat. Sci., Philada., 1868 —178.

Humboldt Co., Nevada.

EOSAURUS, *Marsh.**

This genus, as suggested by Huxley, may be the type of a peculiar division of the Batrachia. There appears to be some probability of this being found to be the case, though present evidence is in favor of Prof. Marsh's location here.

EOSAURUS ACADIANUS, *Marsh.*

Amer. Jour. Science, xxxiv. 1862, 1 Tab. I, II.

Coal measures: Joggins of Nova Scotia.

ARCHOSAURIA.

This great order of Reptilia corresponds with the *Monimostylica* of Müller, without the Testudinata. The latter differ too much in the vertebral and sternal structure to be retained in it.

The important feature which characterizes the order, the close sutural attachment of the quadrate bone, may be readily understood by comparison of the accompanying figures of Nothosaurus from the Muschelkalk of Germany, and Mecistops intermedius Graves,† recent, from the Orinoco, with the plate of Clidastes propython, at the end of the volume.

The order embraces that large series of forms which seem to be equidistant between all the extremes of the Reptilian type. It therefore is not a strictly homogenous group; yet its subdivisions do not appear, with present knowledge, to be sufficiently marked, to render it proper to esteem them of equal value with the other orders here enumerated. This is a usual difficulty of classification; we express it, and do not remove it, by admitting the existence of a protean type in a genus of species, a family of genera, a class of orders, etc., etc. The suborders are as follows:

Limbs without flexible articulation; natatory; no femoral trochanters; no sacrum.
A procoracoid united with scapula; a distinct episternum.
Ribs single headed.

* The following species have been described by Leidy, who refers them to Reptilia with doubt, and says they may be fishes. As this point remains undecided, I can only allude to them here.

CYMBOSPONDYLUS, *Leidy.*

Proceedings Acad. Nat. Sciences, Philada., 1858.—178.

CYMBOSPONDYLUS PISCOSUS, *Leidy, l. c.*

? Triassic of Humbuldt Co., and of the Toiyabe Range, Nevada.

CYMBOSPONDYLUS PETRINUS, *Leidy, l. c.*

? Triassic; Humboldt, Nevada.

† This cut is taken from the type specimen of *Mecistops bathryhynchus*, in Mus. Academy. The Nothosaurus is the N. andriani or a nearly allied species. I am not quite positive that the number of alveoli on the maxillary bone is exactly correct.

Fig. 3.

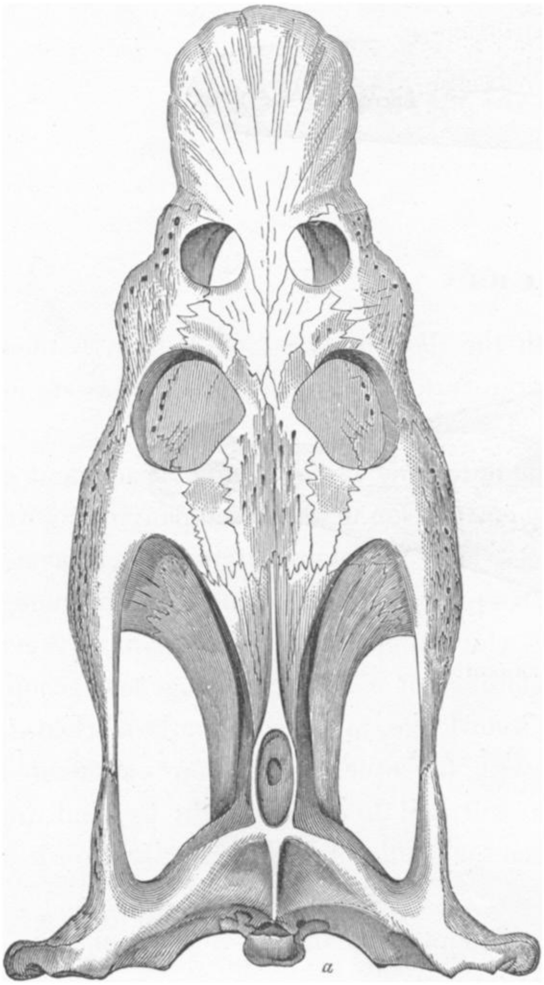
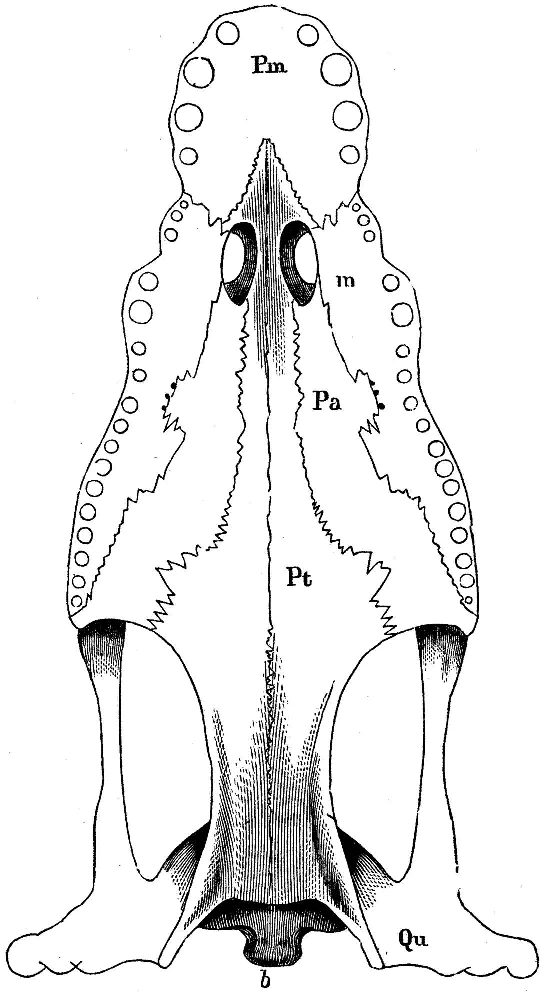


Fig. 4.



NOTHOSAURUS ? ANDRIANI.

External nostrils posterior.
Pubes entering acetabulum, transverse, united medially.
Vertebræ with zygapophyses only.
Ribs single-headed. Chevron bones present.

SAUROPTERYGIA.

Fig. 5.

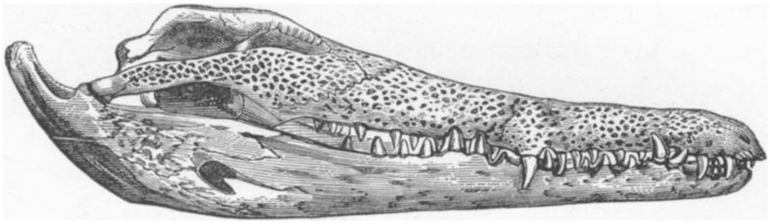
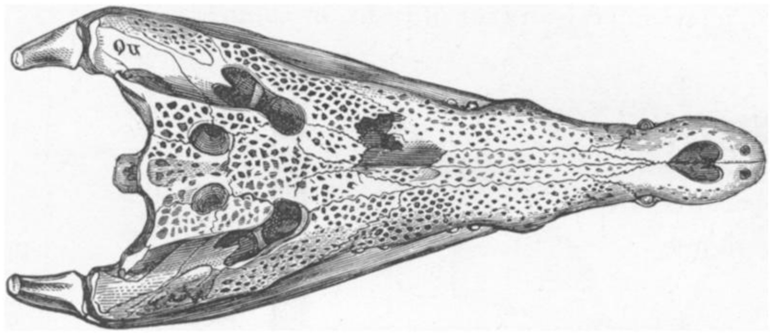


Fig. 6.



MECISTOPS INTERMEDIUS.

Limbs ambulatory, no third trochanter.
Sacrum of two vertebræ.
No procoracoid or clavicle.
Ribs mostly double-headed.
External nostrils anterior.
Pubes longitudinal, not entering acetabulum; free distally.
Zygapophyses only; chevron bones

CROCODILIA.

Limbs ambulatory; a third trochanter on femur.
Sacrum of two or three vertebræ; acetabulum entire; pubes united.
Ribs double-headed.
External nostrils posterior.
Zygapophyses only and chevron bones.

THECODONTIA.

Limbs ambulatory or prehensile.
Ilium horizontal, supporting a long sacrum of five or six vertebræ, the anterior derived from the lumbar series.
The acetabulum thrown forwards, and not complete, but perforate.

Ischium long longitudinal, posterior, supporting the pubis in front on a process.
Ribs free, double headed.
Neural arches united by suture; chevron bones present.

DINOSAURIA.

Limbs ambulatory.
External nostrils anterior.
Inferior pelvic elements in contact transversely, acetabulum imperforate.
Sacrum of six vertebræ.
Neural arches attached by suture.
Premaxillary single or double;
Teeth wanting or represented by a pair of tusks, or canines.
No columella. ANOMODONTIA.

Limbs ambulatory.
External nostrils anterior.
Inferior pelvic elements in contact transversely.
Sacrum of two vertebræ.
A columella.
Clavicle, episternum and xiphisternum present, united.
Chevron bones. RHYNCHOCEPHALIA.

The important modification in the mode of articulation of the quadrate bone, which characterizes this order has been overlooked in most of the systematic arrangements of the extinct and living Reptilia. The subordinate forms differ in important points, but the groups Sauropterygia, Thecodontia, and Crocodilia, appear to be related by a close bond, as for example the marine, the terrestrial, the Sphargid, and the Pleurodire tortoises. The extremities are modified for all modes of progression, except that of flight, in both; while as much gradation between these types is seen in one as in the other. In the characters of the anterior and posterior nasal openings, there is a great range in these types, but the transitions in these respects occur successively from Crocodilus to Teleosaurus,* to Belodon, to Plesiosaurus and Nothosaurus.

An important definitive character is found in several types of the Archosauria. The pterygoid bones are prolonged anteriorly between the palatines, and frequently as far as the vomer, completely separating the palatines. The latter then lie exterior to the pterygoids and between them and the maxillaries. When they bear teeth the latter form a series within and parallel to that of the maxillary bone.

This structure occurs in Sauropterygia, as Nothosaurus, (see fig. 4,) and in Rhynchoce-

*See Huxley on relations of Plesiosaurus to Teleosaurus, Journ. Geol. Soc. Lond.

phalia (Sphenodon Hyperodapedon.) I have not observed it in any of the Crocodilia, but the palatal roof of several genera of this order is unknown. No such structure is known among the Streptostylicate Reptilia.

This order appears first in time, in its Sauropterygian and Thecodontian representatives in the Trias, and in the genus Protorosaurus Meyer, even in the Kupferschiefer, a member of the Permian. At the same time it is the only one of the characteristically extinct types, which remains to the present day. This it does in the Rhynchocephalia and especially the Crocodilia, the most persistent reptilian type. It must also be observed that the Trias of Scotland has yielded a type (Leptopleurum), which Huxley refers to the Lacertilia.

SAUROPTERYGIA.

POLYCOTYLUS, *Cope.*

This genus is established on a series of vertebræ with portions of pelvic arch and posterior extremity, discovered in the upper Cretaceous of Kansas by W. E. Webb, Superintendent of the land office in Topeka, Kansas. The point at which the remains were found is about five miles west of Fort Wallace on the plains near the Smoky Hill river, Kansas, in a yellow Cretaceous limestone.

The animal thus indicated is of interest in American vertebrate palæontology, as the first true Plesiosauroid discovered within our limits. That its affinities are nearer to Plesiosaurus than to Elasmosaurus will be apparent from the following description.

There are wholes or portions of twenty-one vertebræ, of which but two retain their neural arches, and six are represented by neural arches only. Four centra may be referred to the caudal series, the remainder to the dorsal; there is nothing to indicate the characters of the cervical vertebræ. All of these vertebræ, except the distal caudals, are remarkable for their short anteroposterior diameter and deeply concave articular faces. This concavity is not however of an open conic form, as in Ichthyosaurus, but is flattened at the fundus, thus exhibiting a small slightly disciform area. The usual pair of venous foramina appears on the under side of the centum. The neural arch is continuous with the latter, and exhibits no trace of connecting suture. The diapophyses arise from the neural arch in all the dorsals; they are compressed and vertical in section. The arch is of course narrow anteroposteriorly, and presents a pair of moderately prominent zygapophyses in each direction, the posterior as usual articulating downwards, the anterior upwards. On some of the vertebræ they become closely approximated. The neural spines are narrow anteroposteriorly, but much stouter transversely than in Elasmosaurus; they are strongly grooved at the base, both anteriorly and posteriorly, most so posteriorly.

The caudal vertebræ are anteriorly quite as large as the dorsals. Two anterior caudals present on the latero-inferior part of the posterior margin, a pair of widely separated articular surfaces for chevron bones. A portion of one of the latter remains; it is narrow and sub-cylindric at the base. The diapophyses are situated on the upper part of the centrum, and are continuous with it, and without trace of suture. There are two distal cervicals, which are much smaller than the preceding. They are solidly coössified and have been broken from one anterior to them, with which they have been also anchylosed. Processes in the position of diapophyses have disappeared, while a strong infero-lateral process projects from the middle of each, similar in position to the parapophyses (or whatever they may be) of the Elasmosaurus. These processes are decurved and much thickened and rugose; they may be described as more or less elongate conic. The neural canal of these vertebræ is well marked, though small. The coössification of cervical vertebræ is a remarkable character, and very unusual. It does not seem probable that these specimens represent a diseased condition, since they are symmetrical, and the inferior surface and foramina are unaffected. The rugosity is much that of a ligamentous articulation. Their size indicates a remarkably slender neck as in Plesiosaurus, but even more so, and perhaps as elongate as in Elasmosaurus.

That the portions of an extremity alluded to, belong to the posterior, is rendered probable by the presence of part of an ilium, and by the fact that the portions of the vertebral column secured, are chiefly median and posterior. The fragments consist of the extremity of the femur, the tibia, several tarsal bones, and numerous phalanges. The whole limb is of great size compared with that of the vertebral column, and indicates powerful natatory capacity in its possessor. What the relative length of the femur may be, cannot be ascertained, as the proximal portion is wanting, but if it were like the tibia, it was characterized by stoutness rather than by length. The portion remaining is flattened, and presents distally two distinct articular faces for ulna and radius, instead of the uniformly convex outline characteristic of most of the species of Plesiosaurus. The tibia is broader than long, and not emarginate externally. The fibula is wanting. One of the tarsal bones is a flat unequally hexagonal disc, of less thickness than the tibia and the tarsals which appear to connect with it. One of the latter is transverse parallelogrammic, with three faces of broad plane articulations and the outer rounded in section. Another tarsal or metatarsal is a parallelopipedon, except that one extremity presents two faces meeting at a right angle. Another is similar, but oblique, *i. e.*, rhombic in section; one of the longitudinal angles is also prolonged.

Of the phalanges there are individuals from three series. Portions of flat bones, perhaps, belonging to the pelvic arch, indicate, as do all the other pieces, that the bony structure in Polycotylus is more massive than in Elasmosaurus, if the only known species

has not attained such huge dimensions as some of the latter. These fragments do not throw much light on the structure of the pelvic arch.

The structure of the bones is, like that in the order generally, of the coarsest description. There are no medullary cavities, but the medullary cells are large, and extended everywhere in the direction of the axis of each bone.

The characters which separate this genus from Plesiosaurus may be derived from the preceding as follows:

First; the deeply biconcave, and very short vertebral centra.

Second; the tibia broader than long, resembling those of Ichthyosaurus.

Third; the coalescence and depression of some of the cervicals.

Fourth; the continuity of the neural arches.

Fifth; the continuity of the diapophyses of the caudals.

The only genus with which this genus compares nearly, is the Thaumatosaurus of Meyer. This is known but by a few fragments, and of these, but few are present in the Kansas animal. The character on which I rely at present to distinguish them, is the much less concavity of the dorsal vertebræ in Thaumatosaurus. This is however, not entirely satisfactory. Thaumatosaurus oolithicus Meyer is from the lower oolite of South Germany.

The bones are thoroughly mineralized, and the adherent matrix is a light yellow chalky limestone, similar to that which yielded the fine fragments of the Macrosaurus proriger. This, Dr. Leconte informs me, is probably Meek and Hayden's upper Cretaceous No. 3, and is a higher horizon than that near Fort Wallace from which Dr. Turner procured the Elasmosaurus platyurus. The specimens were all taken out under the direction of W. E. Webb, of Topeka, from the same spot; from every point of view there is reason to believe that they belong to the same animal.

POLYCOTYLUS LATIPINNIS, *Cope.*

The anterior dorsal vertebræ have the centra slightly compressed or vertically oval, while the posterior are more rounded. The anterior caudals appear to have been round or nearly so; they are somewhat distorted by pressure. The sides of the centrum are slighly concave in the longitudinal direction; below, there is no carina, but at least two venous foramina. There is another large foramen on the side of the centrum, usually not far from the neural arch; there are usually other smaller foramina below this. The bases of the diapophyses are longitudinally grooved behind, and separate a concavity of the arch in front of them from one behind. In the most median, the most elevated diapophysis stands about equally on the neurapophysis and the neural spine above it. The diapophysis are vertically compressed, and the costal articulation of the only one preserved, is in the same plane. The margins of the external surfaces are not coarsely striate as in many Sauropterygia. The venous foramina of the distal coössified cervicals are in pairs, and of a large size. In the proximal caudals the diapophyses are above the middle of the sides of the centra. In one the basis of a chevron is preserved. It is cylindric and striate. The zygapophysis

on the hinder aspect of a dorsal has a disciform articular surface directed outwards and downwards : the prominence of its upper face is continuous with the lateral ridge of the neural spine. The anterior uplooking surface is equally small and little divergent.

	Inches.
Vertical diameter centrum dorsal,	3.42
Transverse " " "	2.7
Antero-posterior diameter centrum dorsal, (below,)	1.85
Vertical diameter centrum dorsal, (poster,)	2.98
Transverse " " "	2.9
" " neural canal,	.86
Longitudinal diameter base neural spine,	1.22
" " " diapophysis	1.2
Length between extremities zygapophyses, (dorsal,)	2.26
Depth of cup of vertebræ,	.63
Length centrum anterior caudal,	1.73
Distance between bases chevron bone, (caudal,)	2.58
Length two coossified caudals,	2.5
Width anterior in front,	1.7
Depth " "	.9

It may be observed the anterior caudals have a nearly round articular extremity; one of them is a little wider than high, but they are too much distorted to furnish reliable measurements.

The portion of ilium preserved is an extremity. It is flat on one side and convex on the other. The shaft is solid. The articular extremity is oblique, and presents a truncate extremity, which is at right angles to a short recurved margin, which has been an insertion or articulation; the flat surface is rugose distally. Long diameter of extremity, 2 in. .75; of shaft, 1.9 in. The articular faces of the extremity of the femur are at an open angle with each other, and are strongly concave in transverse section. The femur is here very flat, with narrow margins; it becomes stouter with diminishing width. Distally the surface is marked by grooves and small foramina. What may be tibia is the basal frustrum of a wedge ; the articular faces broad, the outer margin narrowed ; the faces slightly concave. The inner margin is shorter than the outer, and the distal part of it presents a broad articular face. Some of the tarsal bones have been already described. There are thirteen metatarsals and phalanges. They are of stout proportions and are considerably constricted medially. Those of one series are square in section ; those of another, transverse ; those of the third transverse with one edge thinned or acuminate in section. Some of each form are more elongate than others.

	Inches.
Width femur at extremity, (restored,)	8.
Depth " " (median,)	1.3
Width " four inches from extremity,	6.
Thickness femur " " "	1.95
Width tibia,	3.88
Length externally,	2.6
Width tarsi tibiale,	2.48
Thickness " "	1.52
Length parallelopiped phalange,	1.56
Width " "	1.2
Thickness " "	1.2
" depressed "	1.
Width " "	1.4
Length " "	1.9

These powerful extremital pieces indicate a body to be propelled, of not less than usual proportions. If this be the case the number of dorsal vertebræ is considerably greater than in the species of this order in general, and approaching more the Ichthyosauri. I do not intend to suggest any affinity between the latter and the present genus, as none exists. What the extent of cervical vertebræ may have been is uncertain. The caudals have probably been numerous, though not probably so extended as in Elasmosaurus.

The size of the species can be approximately estimated from the proportions furnished by Owen (Reptiles of the Liassic Formations) for Plesiosaurus rostratus. The skeleton of this species measures 11 feet 8 inches, and the dorsal vertebræ are of less vertical and equal transverse diameter compared with those of the present Saurian. We may therefore suppose that the latter exceeded the former in dimensions.

William E. Webb of Topeka discovered the specimens on which this species rests, and liberally forwarded them to me for examination and description.

ISCHYROSAURUS, *Cope.*

Ischyrotherium Leidy. Trans. Amer. Philos. Soc, 1860, 150.

This genus has been referred by Leidy to the Mammalia, and to the order Sirenia, with doubt. Having access to a part of the remains on which it was established, I have arrived at the conviction that it really represents an aquatic Saurian more or less distantly related to Plesiosaurus. My reasons for regarding it as Reptilian and not Mammalian are: first, the articulation of the neural arch with the centrum; second, the absence of epiphyses; third, the absence of articulation for the head of the rib on the centrum; fourth, the lack of tuberculum on the ribs.

With respect to the first of these characters, it may be remarked that it never exists in mature Mammalia, and disappears at an early period of the development of all, except in certain seals and the Echidna, where the consolidation of the neural arch is a little delayed. As to the epiphyses, there is no trace of their suture to be found on fractured surfaces, supposing their existence to be indicated by the series of foramina extending on the inferior surface of the centrum near each articular extremity. These foramina are, I believe, merely the ruptured coarse cells, which can be found near the articular faces in the vertebræ in all Sauropterygia. They are unusually small in this genus, appropriately to the denser structure of the bones as compared with other sea saurians. The articulation of the rib takes place at the extremity of a long diapophysis, and there only, there being no pit for the *capitulum.* This does not occur in Mammalia, but is highly characteristic of the lower groups of the Reptilia, especially the Sauropterygia. The lumbar series in Cetacea presents a somewhat similar structure. The vertebræ in question are referred by Leidy to this position, but they are clearly median dorsals, from the elevated position and length of the diapophyses. The simple form of the ribs, some of which are from the same part of the column, is quite unknown among Mammalia.

There are other significant characters of less value, which point to the saurian affinities of this genus, and confirm the preceding. These are the very small size of the neural canal, the cylindric or thickened form of the neural arch, and the strong venous foramina

penetrating the centrum, which, though not wanting in such mammals as Basilosaurus and its allies, are neither so numerous nor situate so near the neural arch as here. (See Leidy's fig. 11.)

The ribs, as remarked by Dr. Leidy, are remarkably dense. He observes that "from the solidity of structure and cylindroid form of the ribs, I suspect *Ischyrotherium* to be more nearly allied to the Manatee than to any other animal." This consideration does not affect the affinities here accepted as true. The structure is remarkable, and differs from that of Manatus and Squalodon much as Reptiles do from Mammals, in its homogeneity, or when interruption of the same occurs, in its appearance as irregularly disposed cells, and in the lack of a concentric structure of any kind. In the Mammalian genera in question, as well as in Basilosaurus* this concentric structure is eccentric in relation to the circumference of the rib.

The genus Mesosaurus Gervais, according to plate XLII of his Zoologie et Palæontologie Generale (the letter press has not yet reached me), presents ribs of similar form to those of Ischyrosaurus, but whether of similar structure I cannot ascertain.

Leidy concludes his description of this genus with the following remarks: "Although I have supposed the remains * * to indicate * * an animal allied to the Manatee, * * I have suspected that they have belonged to an aquatic reptile unlike any known." * * Entertaining the opinions that I do respecting the relations of the genus, I have thought that the name applied by Leidy, which is appropriate only to a mammal, should be changed. I therefore call it Ischyrosaurus, maintaining the first etymology so far as practicable.

I refer it to the Sauropterygia, as the parts resemble Plesiosaurus more nearly than those of any other American genus. The density of the osseous structure and the cylindric form of the ribs, will distinguish it from Plesiosaurus; from Polycotylus the form of the vertebræ separates it at once.

I suppose that this type may have been of estuary habits, and took its food in proximity to land. The density of the bones is not known in, nor is it appropriate to, animals of the open ocean. The presence of Hadrosaurus (Thespesius) occidentalis in the same beds, is further evidence of the proximity of land.

ISCHYROSAURUS ANTIQUUS, *Leidy*.

Ischyrotherium antiquum, Leidy. Proc. Ac. Nat. Sci., Phila., VIII, p. 89. Trans. Amer. Philos. Soc. 1860, 150 Tab. X, figs. 8-17.

The dorsal vertebræ of this species present plane articular extremities. The centrum is not constricted medially, but presents a shallow concavity round its median portions. The sutural articulation of the neural arch is shallow, sub-ovate, and extends throughout the length of the centrum. The diapophyses are compressed cylindric. The

* See Owen on this genus.

articular face is a transverse oval. The size of the animal is similar to that of the Plesiosauri of medium dimensions, perhaps ten feet in length, admitting elongate neck and tail, of which there is no evidence.

Position.—Bed Q. Hayden's Section of Great Lignite basin of Nebraska. (Trans. Am. Philos. Soc., 1860, 135.) perhaps of the Cretaceous age; from the Moreau River.

PLESIOSAURUS, *Conyb.*

I refer the following species to this genus provisionally, and with doubt.

PLESIOSAURUS LOCKWOODII, *Cope.*

This reptile is represented by but few remains, which are in the private collection of Dr. Samuel Lockwood, of Monmouth County, N. J. A single dorsal vertebra, which he kindly lent me for description, presents characters which are so marked when compared with other marine Sauria as to require notice.

The centrum is of the general form of Plesiosaurus and Cimoliasaurus, and the arch has a sutural attachment as in the former. The suture is the surface of a sub-round pit, almost like that of Ichthyosaurus, and not like that typical of Plesiosaurus, or the young of Cimaliosaurus magnus. In the latter the suture is an oval concavity which extends throughout the length of the centrum. The pit in this species measures little more than one-third the length of the centrum. The floor of the neural canal is quite flat. The sides of the centrum are strongly and regularly concave, rather less strongly below than laterally. The margins flare regularly, and are not striate grooved or ribbed as in many species. There is a strong venous foramen a short distance below the neural arch and two medially below.

The species is further characterized by the regularly concave articular faces, without median plane or prominent portion, as in Cimoliosaurus species. They are more concave than those of the Elasmosauri also. The form of the surface is entirely circular.

	In.	*Lin.*
Width articular surface,	2	8
Depth " "	2	7.8
Width pit neural arch,		8.4
Length centrum,	1	11.6

This species I have dedicated to its discoverer, Dr. Lockwood, who has contributed in various ways to the progress of Natural Science.

It is the earliest sea saurian from this country, as it was derived from the clays which underlie the lower green sand bed. It was dug from a brick clay pit near Matteawan, Monmouth County, N. J.

CIMOLIASAURUS, *Leidy.*

Cimoliasaurus and Discosaurus, Leidy. Proceed. Academy Nat. Sci., Phila., 1851, 325—1854, 72, tab. ii, figs. 4, 5, 6, and 1851, 326; Cretaceous Reptiles, 22 and 25, tabs. IV., V., VI. *Brimosaurus* Leidy, Pr. A. N. Sci., Phila., 1855, 472.

This genus has been chiefly illustrated by Leidy, who has described remains of its species from the cretaceous deposits of many of the States east of the Mississippi. It has remained for the discovery of Elasmosaurus to prove that the two supposed genera named by Leidy, are really one, his supposed caudals of *Discosaurus** being really caudals of Cim-

* This genus was originally proposed on two vertebræ from Georgia, and a vertebra from New Jersey described by Dekay. He afterwards added vertebræ from Alabama, Mississippi and New Jersey. Some of these were regarded as cervicals; they are, however, anterior caudals. As Leidy observes, there are several species among them, and it may be, several genera, but as the genera cannot be distinguished by the caudal vertebræ, it appears to me that *Discosaurus* cannot be preserved. While distinguishing the genus from Cimoliasaurus, Leidy adds, "The supposed caudals of Discosaurus I have suspected to be anterior cervicals, notwithstanding the apparent provision for the articulation of chevron bones. If all the vertebræ be viewed as belonging to one animal, they represent cervicals, dorsals and lumbars of *Discosaurus;* otherwise they represent a cervical and caudals of the latter, and dorsals and lumbars of *Cimoliasaurus.*" In case of their identity, it may be observed, Leidy refers them all to *Discosaurus.* Cimoliasaurus was, however, proposed first.

oliasaurus, the supposed caudals of the latter proving to be its cervicals. Characters distinguishing it from Plesiosaurus have never been pointed out, and it is here retained apart from it on the supposition that its scapular arch is constructed on the same principle as that of Elasmosaurus, a point, however, which has not been ascertained.

This genus is not as well known as Elasmosaurus, owing to the fragmentary condition in which it is usually found. Its marked character is its short depressed cervical region, as compared with the excessively long and compressed one of Elasmosaurus. It also differs from it in the apparent continuity of the series of diapophyses from the dorsal to the cervical series. In Elasmosaurus these processes are wanting on the anterior dorsals. They are very elongate on the other hand, on the posterior dorsals of Elasmosaurus; in Cimoliasaurus we have as yet no evidence as to their length, as they are broken in our specimens.

Fig. 13.

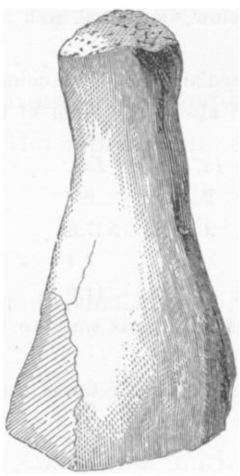


Fig. 14.

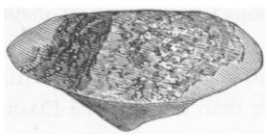


Fig. 15.

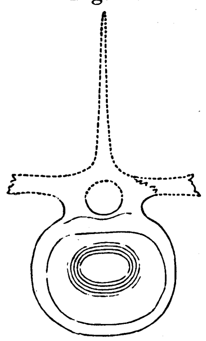
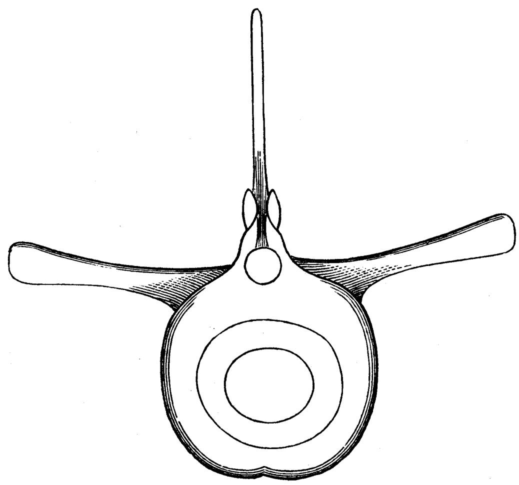


Fig. 16.



The rapid diminution in dimensions of the cervical series in Cimoliasaurus indicates a short neck, and far less slender general form. Leidy suggests from the absence of sacral characters, that posterior limbs have been probably wanting in this genus: the same vertebral characters are seen in Elasmosaurus, but it has a large pelvic and scapular arches; the presence of limbs in it cannot be doubted. The femur of Cimoliasaurus is described below, and is the only limb bone yet assignable to a species of this genus. It resembles that of Plesiosaurus. It is thicker and shorter however than in any species of the latter genus, and is quite short. The distal extremity is thick, and presents pits for the attachment of the articular cartilage; the faces for both ulna and radius are extensive, and indicate a large manus and elongate limb. The rotundity of the head indicates extensive rotation; and we may be satisfied that the animals of this genus were furnished

with powerful propelling flippers. The preceding cut illustrates its form and size in relation to the posterior dorsals from nearly the same position in the C. magnus and Elasmosaurus platyurus.

The general characters of the cervical and dorsal series are very similar to those of Elasmosaurus, but they all exhibit considerably larger neural canals. In the immature individual, the neural arch of the dorsal vertebræ is not coössified, but is separated by suture as in Plesiosaurus.

That there are several species of this genus is suggested by Leidy, and seems probable to the writer. As one of these has been already named, the characters of those which appear distinct may be pointed out.

Anterior caudals, articular faces with rounded margins; antero-posterior diameter greater, 2 in., width, 2 in. 7 l. Pit of diapophysis 1 in. 3 l.

C. VETUSTUS.

Anterior caudals, articular faces with acute marginal angle, antero-posteriorly shorter 1 in. 7 l. by 2 in. 6 l. in width; pit 11 l. Cervical with straight sides and broader form; width 31.2 l. by 24.5 long, the ?diapophysis narrow and stout.

C. MAGNUS.

Anterior dorsals shorter and higher than in C. magnus, the posterior cervicals, therefore shorter than in the same; diapophysis of first dorsal longer.

C. GRANDIS.

Posterior cervical with neural canal as large as C. magnus, but centrum four times as large, and a strong longitudinal ridge half way between pleurapophysis and neural arch, giving pentagonal section: 45 l. long by 52 l. wide; hence longer.

E. ORIENTALIS.

CIMOLIASAURUS VETUSTUS, *Leidy.*

Discosaurus Leidy, Proc. Acad. N. Sci., 1851, 326. Cretaceous Reptiles, N. A., 22. *Plesiosaurus*, DeKay Ann. Lyc., N. Y., 1828, 165, Tab.

If the vertebræ from Alabama from Jos. Jones, described by Leidy in the Cretaceous Reptiles as No. 1, are typical of this species, they present certain peculiarities which distinguish them from those of an individual of C. magnus which I describe below; perhaps the species are distinct.

Cretaceous Alabama, ? Mississippi and ? New Jersey.

CIMOLIASAURUS MAGNUS, *Leidy*.

Pr. A. N. S., Phila., 1851, 325, 1854, 72. Cretaceous Rept. N. A. 25, tab. 00.

This species has hitherto been known from vertebræ only. In connection with vertebræ of this species, I procured a long bone which has a near resemblance to the femur of Plesiosaurus. It indicates a paddle for motion in the water, as has already been mentioned.

The distal breadth is equal to $1\frac{3}{5}$ the length. It is distal compressed, but thick and with rounded margins. The proximal portion is slightly reverted to the condyle, and compressed nearly at right angles to the distal extremity. The condyle is flattened convex and oval in circumference. The tibial and fibular articular faces form a strong angle with each other, and are pitted rugose for the cartilaginous articulation.

	In.	*Lin.*
Distal breadth,	4.	9.
Breadth at neck,	2.	8.5
Diagonal across condyle,	3.	
Length,	9.	11.

It is seen, therefore, that this bone is remarkably robust, much more so than in the Plesiosauri of adult age. That the individual to which it pertained is not mature, appears from the dorsals accompanying, in which the neural arch is not fully coössified to the centrum. We can regard the species as a robust and powerful animal, in which bulk is more prominent than length.

	In.	*Lin.*
Anterior dorsal, length centrum,	2.	5.1
Width do.,	3.	7.
Depth do.,	2.	10.
Length articulation for neurapophysis,	1.	11.
Width do. do.,	1.	1.

The centrum is much constricted medially and the diapophyses are given off from the neurapophyses, the lower margin corresponding with that of the bottom of the neural canal. This specimen is from Barnesboro, and was submitted to me by Prof. Cook, State Geologist.

Locality: the Cretaceous Green Sand of New Jersey; upper bed.

CIMOLIASAURUS GRANDIS.

Brimosaurus grandis, Leidy, Proceed. Ac. Nat. Sci., 1854, 72; tab. I., II.

From Cretaceous of Clark County, Arkansas (near Greenville).

I have not seen any part of this, the largest species. It is, from Leidy's figures and description, distinguished by the relatively greater width and height of its vertebræ, and has been therefore a shorter and more massive animal than its congeners. As nothing beyond Leidy's description is known of it, I append the latter.

It was represented by vertebræ from near Greenville, Clark County, Arkansas. They had been kindly loaned by W. T. Roberts, an agent of the Arkansas Mining Company, who had discovered them with numerous others. Dr. L. stated that, in his visit to St. Louis, Mr. Alb. Koch, the industrious collector of fossil remains, had exhibited to him a collection of bones from the same State, and apparently of the same animal, which he was on the eve of sending to Berlin. The specimens are remarkable for the robust transverse processess, which project laterally from the lower part of the body, and terminate in a large facet for the articulation of a rib. The bodies are cylindroid, and are terminated by slightly concave or nearly flat articular surfaces. The sides of the body are moderately concave, and have an acute margin at the articular surfaces. On each side of a median prominence of the under side of the body a large vascular foramen exists. These vertebræ resemble those of Cimoliasaurus magnus from the

green sand of New Jersey, described previously in the Proceedings of the Academy of Natural Sciences, but in that the large transverse process is cylindrical, while it is compressed cylindroid in the Ark. saurian, and probably the latter belongs to a distinct genus, for which the name Brimosaurus is proposed. The bones are imbedded in a hard limestone with mollusca, and they probably belong to the cretaceous or to the eocene period. One of the most perfect of the vertebræ presents the following measurements:

	Inches.
Length of the body,	$3\frac{3}{4}$
Depth articular surfaces,	5
Breadth do. do.,	6
Length of the neural arch,	3

Dr. Leidy proposes to consider this species as the type of a genus distinct from the present, because its diapophyses are compressed in section, while those of Cimoliasaurus are cylindroid. I think this difference depends on the position in the vertebral column. These processes descend on the anterior part of the column and become more flattened, until they resemble diapophyses of ordinary cervicals. This vertebra therefore was an anterior dorsal.

ELASMOSAURUS, *Cope*.

Leconte's notes on Geology of the route of the Union Pacific Railroad, 1868, p. 68. Cope, Proceed. Acad. Nat. Sciences, 1868, p. 92.

This genus has been more completely preserved to us than any other American representative of the order, and hence may be accepted as most clearly expressive of its characters. In the interpretation of these, however, considerable difficulty has been experienced, as the structure form appears, at first sight, to reverse to a remarkable degree, the usual proportions of known reptiles.

The determination of the anterior extremity of the vertebral column has been rendered certain by the fortunate completeness of the cervical series, as the extraordinary length of the latter, equalling three times that of the body, renders the most careful scrutiny necessary.

The neural arches are every where continuous with the centra, without sign of suture, and are externally plane. The neural canal is exceedingly small for the size of the vertebræ, especially on the lumbars and caudals.

The dorsal vertebræ are remarkable from the fact that the diapophyses disappear on the anterior part of the series, and gradually diminish in length from behind forwards to the point of disappearance. On the median and posterior parts of the series they are very elongate, and rise for a short distance from the basis of the neural arch. Anteriorly, they descend and shorten, and finally remain only as the slightly elevated borders of rib-pits. Throughout the whole of the anterior portion of the column to the cervicals, the neural spines are of great elevation, and of such antero-posterior extent as to be nearly continuous.

The cervical vertebræ are not only more numerous, but become anteriorly much smaller and more attenuated than in its allies of the same family. They are remarkably com-

pressed, the centra much longer than deep, and deeper than wide, and with smooth concave sides.

The ribs of the anterior cervico-dorsal region are inserted directly in the vertically oval pits of the centrum. Immediately at the point where these cease, thin transverse processes appear to arise from the lower edges of the rib pits. They form a continuous series with the ribs, and soon rise from the plane of the lower face of the centrum, and are directed obliquely downwards. At the end of the cervical series they are directed nearly vertically downwards. The number of these vertebræ is very great, the anterior diminishing to a very small size, the whole measuring a little more than half the total length.

Most of the cervicals possess two venous foramina below; the dorsals two, and most of the caudals one.

The resemblance of the caudals to the usual type of Plesiosaurus, is seen in the fact that each bears near its posterior articular aspect, on the inferior face, a pair of articular surfaces, for chevron bones. Similar vertebræ had been described by Leidy as the caudals of a genus he called *Discosaurus;* the study of the present genus shows that they are really of the caudals of the allied genus Cimoliasaurus.

The ribs are simple headed; the abdominal ribs seen in Plesiosaurus are possibly wanting, as none were found by the discoverer of the fossil, after a careful search.

The end of the muzzle, with symphysis mandibuli, was preserved. This is flat, the symphysis rather short, the premaxillary grooved at the intervals between the dental alveoli. The teeth are deeply implanted, with small pulp cavity, are cylindric and furnished with nearly straight elongate conic crowns, which are minutely but sharply striate to the tip; the ridges, straight, continuous. There are no indications of nostrils, so that these were probably posterior and near the orbits, as in Plesiosaurus.

The pelvic arch is more extended than the scapular, and strongly resembles the pelvic arch of other Plesiosauridæ. The scapular arch is peculiar; the claviculi are broad flat bones resembling the pubes of certain tortoises, while the coracoids are much like the coracoids of Plesiosaurus.

The scapular arch is remarkable for the resemblance of coracoids to those of Plesiosaurus. The clavicles have a greater transverse extent than the former, and have a very extensive line of union medially, and a narrow posterior prolongation which meets a similar anterior one of the coracoids, separating the intervening foramina. They appear to form about one third of the walls of the glenoid cavity, and have a constricted base as in some Plesiosauria, applied to the extremity of the coracoid. The form of the glenoid cavity cannot be readily ascertained from the absence of the scapula. What we have of

it would suggest the existence of a fore limb, of comparatively little power, though no remains of such have been found. The acetabulum is smaller than the glenoid cavity; this point, with the obvious source of propulsive power in the tail, renders it probable that the posterior limbs were the weaker of the two, if any existed. But there is no trace of sacrum nor of any modified diapophyses for support of an ilium.

The ischia are flat, subtriangular bones with a long median line of junction, and communicating anteriorly with the posterior prolongation of the pubic plate. Their postero-exterior margins project well backwards. The pubes are broad plates, whose anterior margins diverge from each other. They are broader than the ischia, and form a broad shallow basin for the support of the viscera. The suture defining these elements is obliterated; they are continuous, and form a weak inferior keel on the median line. A simple curved ilium has been preserved, for which there appears to be a smooth articular surface on the pubis to which it was attached.

The acetabular portions of these elements are flattened and furnished with convex articular surfaces. The supposed ilia are short curved bones, resembling that of Plesiosaurus latispinus Ow., or of some of the other species of that family. The shank is flattened cylindric, the distal extremity, dilated rounded and flattened. The proximal extremity sub-truncate, or truncate in two or three unequal planes, and with a median pit. It fits well when applied to a concavity on the articular surface of the pubis. The vertebræ above the pelvic arch were furnished with elongate, sub-cylindric diapophyses.

The question as to the presence of *posterior limbs* remains unsolved. Dr. Turner having made a second careful search, and renewed excavations at the original locality, failed to find any bones which can be assigned to humerus, ulna, radius, carpus or phalanges, or similar elements of the hind limbs. This is the more remarkable, as the pelvic and scapular arches were further completed, and an additional number of ribs obtained. The inferior and lateral regions of the trunk, being then so abundantly discovered, what are we to think of the entire absence of the usually numerous elements of extremities? The glenoid cavity is a rather angular cavity, and both were filled with solid argillaceous matrix. The acetabula are not cup-like, but merely exposures of the marrow, plane extremities of the pubes and ischia; they were covered with thin layers of gypsum; the pieces of the ilia were found imbedded in the mass of matrix which occupied the pelvic arch.

The allied genus Cimoliasaurus Leidy possesses a femur, as described under head of that genus; it is of shorter and thicker form than in most Plesiosauri.

The skeleton so nearly complete would indicate no violent disturbance of the carcass; but if there were, it would be an unusual accident that all of the four limbs should have been removed from their sockets, without leaving even fragments.

This genus is well distinguished from Plesiosaurus by the peculiarity of the scapular arch. The mesosternum appears to be coössified with the claviculi, and the three elements form a broad breast-plate. If the claviculus was ever united with the scapula as in Plesiosaurus, no evidence of it can be seen in the specimen. Both the clavicular and mesosternal elements are broader and more extended anteriorly.

The American genera of Elasmosauridæ may be compared as follows:

Posterior cervical vertebræ without diapophyses: cervicals longer, compressed, neck very elongate.

ELASMOSAURUS.

Posterior cervical vertebræ with diapophyses: cervicals quadrate, shorter, depressed, rapidly diminishing in size, hence the neck shorter.

CIMOLIASAURUS.

Prof. Owen figures and describes (Reptiles of the Cretaceous, Palaeontogr. Soc.) a vertebra which very closely resembles the cervical of Elasmosaurus. He considers it to be the cervical of a peculiar Plesiosaurus, which he calls P. constrictus, remarking, at the same time, its remarkably inferior pleurapophyses. This I believe to be a species of Elasmosaurus or an ally, and to be called for the present Elasmosaurus constrictus.

ELASMOSAURUS PLATYURUS, *Cope*.

Leconte's Notes loc. cit. Proceed. Acad Nat. Sci., 1868, l. c. 92.
Discosaurus carinatus, Cope. Leconte's Notes, l. c.

This, after Mosasaurus the most elongate of the sea saurians yet discovered, is represented by a more than usually complete skeleton in the Museum of the Academy of Natural Sciences in this city. It was found by Dr. Theophilus H. Turner, the physician of the garrison at Fort Wallace, a point situated 300 miles westward from Leavenworth on the Missouri river, and some distance north from the Smoky Hill Fork of the Platte river. Portions of two vertebræ presented by him to Dr. Leconte when on his geological tour in the interest of the U. S. Pacific Railroad Company, were brought by the latter gentleman to the Academy, and indicated to the writer the existence of an unknown Plesiosauroid reptile. Subsequent correspondence with Dr. Turner resulted in his employing a number of men, who engaged in excavations, and succeeded in obtaining a large part of the monster. Its vertebræ were found to be almost continuous, except a vacancy of some four feet in the interior dorsal region. They formed a curved line, a considerable part of whose convexity was visible on the side of a bluff of clay shale rock, with seams and crystals of gypsum. The bones were all coated with a thin layer of gypsum, and in some places their dense layer had been destroyed by conversion into sulphate of lime.

The scapular arch was found in large part adhering to the bodies and neural spines of a series of the anterior dorsal vertebræ, and was detached from it at the Academy. The pelvic arch had been slightly crushed, and the lumbosacral vertebræ forced into contact with the ischia, where they remain. A broken extremity of the supposed ilium was forced into the matrix which supports the ischia. Many of the dorsal and caudal vertebræ were sent, and remain in continuous masses, so that the succession is readily traced, and the true relations of the extremities preserved.

In removing the matrix from beneath the vertebræ, scales and teeth of some six species of Physoclyst and Physostomous fishes were found, including an Enchodus and a Sphyraena, the latter indicating a new species, which I have called S. carinata. These animals had doubtless been the food of the Elasmosaurus.

The end of the muzzle was broken from a part or the whole of the cranium, which has not been rediscovered, though Dr. Turner has made careful search. It was found in front of the vertebræ here regarded as cervical, at some distance from them.

The whole skeleton has been under considerable pressure, so that most of the ribs have been pressed flat on the vertebræ; the long parapophyses of the cervicals have most of them been fractured at their bases and compressed, those of opposite sides thus approaching more nearly in the form of chevron bones than they otherwise would have done. The proximal cervicals are obliquely flattened by the pressure; the other cervicals have the bodies naturally flat, with the articular surfaces much less so than the median portion. Some of the caudals are obliquely distorted.

Description— Vertebræ.—The neck may be safely assumed as a point of departure, as it consists of above sixty mostly continuous vertebræ, which graduate to an atlas of very slender proportions. Most of them preserve more or less developed parapophyses. At the posterior extremity of this series, sixteen are perfectly continuous, and in this portion a great gradation in form is apparent. The anterior are narrow, compressed, and similar to the more distal cervicals in the elevated position of the lateral angle; the anterior are subquadrate, thick, and with lower lateral rib, and stronger ? pleurapophysis. In these respects the latter resemble the dorsals which follow, towards what I believe to be the tail. Four anterior dorsals are in one mass (figured in plate 3); in this series the lateral angle first approaching, is finally lost in the margin of the rib-pit, the posterior thus resembling other dorsals. There can be so far little doubt that the anterior and posterior extremities of the masses are correctly interpreted.

In a series of four anterior dorsals, which like the preceding, are in their original continuous mass, those of one extremity have centra rounded in section, with inferior rib-pits; those of the other have quadrate centra and elevated diapophyses; the former have the character of the first dorsals, the latter of the median dorsals. The posterior dorsals and anterior caudals form in like manner a continuous series of eleven vertebræ, fractured in four places. In them the diapophyses steadily descend, reaching the inferior plane in the last, thus with the reduction of the venous foramina to one, at the seventh, indicating the point of transition from dorsal to caudal series. The zygapophyses preserve the usual arrangement, but are much compressed, so that the posterior or down-looking, are confluent, and scarcely separated by an emargination.

The neural spines at their bases have a slight posterior obliquity, and the superior portion leans strongly in the anterior direction. The inferior limbs of the cervical pleurapophyses appear to be entirely wanting. The articular faces for the chevron bones are seen at the extremity of the inferior rib of the caudal.

Of the cervicals there are both axis and atlas. Of the caudals, probably the distal half, at least, is lost. A single vertebra near the middle does not relate to either of those anterior or posterior to it. There are, therefore, at least four lost from that region also.

There is a considerable interruption immediately anterior to the last dorsal vertebra. Three large vertebræ, with long diapophyses, belonging here, were imbedded in the hard matrix which protected the pelvic arch. These are far from relating immediately to the vertebræ preserved before and behind them. I estimate the number missing as follows: Seven of the fourteen dorsals preserved have more or less elongate diapophyses. In the Plesiosauri, vertebræ of this character, are much more numerous; in P. homalospondylus Owen gives seventeen. If we add ten to the series in the present species it will give the abdominal space between the adjacent margins of the o. o. pubis and coracoidea an extent equal to the length of the pelvic arch. This is relatively shorter than in the Plesiosauri. Dr. Turner found that a space of "three or four" feet intervened between the two portions of the skeleton, which was otherwise continuous. I think ten an average number to represent safely the missing dorsals.

From the cervical proximal regions probably three vertebræ are missing from two interruptions. The remainder of the cervical series exhibits three interruptions. Most of the proximals have been broken medially, leaving the ticulations solid, an advantage in determining their continuity. Three vertebræ and one-half are thus found to be missing in this region.

The whole number of vertebræ preserved and lost, with the relative lengths of each, may be stated as follows:

	Present.		Lost.		Total
	No.	Length In.	No.	Length In.	lengths.
Cranium,				24	24
Cervicals,	68½	257.5	3½	22.3	279.8
Dorso-lumbars,	14	55.10	10	37.6	93.4
Caudals,	21	60.4	30	60.	120.4
Total,	103½		43½		517.6

This gives the total length to the animal of forty-three feet, two inches, which, increased by the amount taken up by intervertebral cartilages, will give roundly about forty-five feet. Of this, twenty-two feet must be reckoned to the neck.

Measurements.

The cervical vertebræ from the sixty-sixth to the thirty-ninth are all longer than the dorsals; they commence four inches in length, increase to five, and diminish to four again.

	In.	Lin.
Length of sixty-third cervical,	4	9.2
Depth articular face of the centrum,	3	8.
Width " " "	3	10.2
Total elevation ninth do.,	2	9.
Length ninth caudal,	1	7.5
Transverse diameter articular face,	1	6.
Vertical " articular face do.,	1	27.
Length head of rib,	1	9.7
Width " "	1	3.
" shaft "	1	10.5

Many of the *ribs* preserved have been pressed upon the vertebræ and crushed.

The first *dorsal* is that vertebra which first presents a distinct articulation for a rib. The diapophyses are never much elevated above the centrum and are longest on the thirteenth (inserting seven supposed to be lost). Their form is stout and much depressed, and distally expanded. They diminish gradually, and on the third are represented by a longitudinal, slightly concave articular surface, somewhat similar to those of the caudals. This surface is bounded above and below by a longitudinal, angulation; the superior is first distinct on the first, and bounds the articular surface last on the third. They give the transverse section of the posterior cervicals a pentagonal form; that of the anterior dorsals is nearly circular. The latter are strongly constricted medially, and the articular faces are slightly concave. The external surface near the included angle is coarsely ridged, in conformity with coarse cellular texture of the spongy bone. The venous foramina gradually become more widely separated, approaching each other again on the posterior cervicals. On the dorsals they occupy the bottom of a more or less pronounced concavity. These concavities, on the posterior dorsals, are bounded externally by a strong obtuse longitudinal angulation, giving a quadrate outline to the section of the centrum in this part of the series.

The posterior cervicals are not readily distinguished from the anterior dorsals. In the latter the ribs appear to be present, of reduced length, judging from the smaller size of the remaining heads. The articular pits continue to descend till their lower marginal ridge is the inferior lateral angle of the vertebra. On such vertebræ the inferior surface is flat. The neural spines on dorsals and posterior cervicals are of great height as well as antero-posterior width, and they allow a very narrow interval between them.

	In.	Lin.
Antero-posterior diameter ?12th dorsal,	3	7.2
Transverse diameter articular surface,	4	10.
Vertical do. do.,	4	2.5
Neural canal and spine (latter broken),	5	3.5
Length diapophysis 12th dorsal,	4	
Width diapophysis at middle,	1	10.

	In.	*Lin.*
Antero-posterior diam. ?11th dorsal,	3	4.5
Transverse posterior of articular face,	5	3.
Vertical do. do. do.,	3	10.
Transverse posterior of neural canal,		10.2
Transverse posterior of articular face, 3d dorsal,	5	2.5
Elevation centrum, arch and spine, 2d dorsal,	11	9.
Elevation upper edge zygantrum 2d dorsal,	6	
Length zygantrum, upper edge, do.,	1	10.2
Length centrum, last cervical,	4	
Width centrum articular face cervical,	5	3.
Elevation neūral arch and spine cervical,	7	9.
Antero-posterior width neural spine of cervical at zygapophysis,	3	7.

The cervical vertebræ are assumed to commence where the rib pits cease, and the continuous lateral processes commence. This point is ascertained with difficulty on the specimen. It is, however, perhaps the same point where the longitudinal lateral ridge leaves the upper margin of the rib pit; and it was to the series of vertebræ which pass this point, the scapular bones,—the clavicle and coracoid were found attached. On the anterior dorsals the inferior margin of the rib pit is most prominent, and is finally produced in a flat thin process which is directed obliquely downwards. Both these and the posterior ribs are crushed on the centra and project obliquely below them; their mode of attachment is thus rendered rather obscure. A similar structure exists in the posterior cervicals of Cimoliasaurus, while on the anterior dorsals or where the rib-origins are on the lower plane, short thick diapophyses support the ribs. The proximal cervicals are remarkable for their compressed and elongate form. They are for a considerable distance longer than any dorsals. The lateral longitudinal ridge rises successively nearer to the neural arch and disappears. The articular surfaces are vertically oval, flattened above and below. The inferior faces are slightly grooved in line with the venous foramina. These vertebræ diminish in length, and after the posterior third of the series, materially in depth. They diminish to terminal ones of very small size. In most the decurved ?pleurapophyses are broken near the base, but the basal portion of various lengths generally adheres. They are as wide as a rib; and scarcely half as thick. On some of the most anterior vertebræ, they are quite short and broad antero-posteriorly. They have much greater antero-posterior extent on the terminal than the proximal cervical centra, having a base five-sixths the length of the latter. The zygapophyses have relatively a larger size on these than any other vertebræ. In such the centrum is less compressed, though with concave sides, and with a section rather quadrate.

The *caudal vertebræ* have slightly concave articular surfaces, which are not bounded by groove or ridge. The neural arches have flat sides, and there is no longitudinal ridge above the diapophyses. The neural spines are elevated, the margins of those of the adjacent vertebræ close together. The diapophysis is very short and wide, terminating in a large oval concavity for the pleurapophyses. Each limb of the chevron bone is attached to an articular surface on the lower posterior face of the vertebra, at the extremity of a strong inferior ridge. These inferior ridges are rather close together, and distinguish the vertebræ from those of Cimoliasaurus magnus, where they are wanting. They are absent on the anterior seven of the caudal series. The diapophysis is nearer the anterior than the posterior face of the vertebra. The venous foramen is single and median, on all but the last six cervicals.

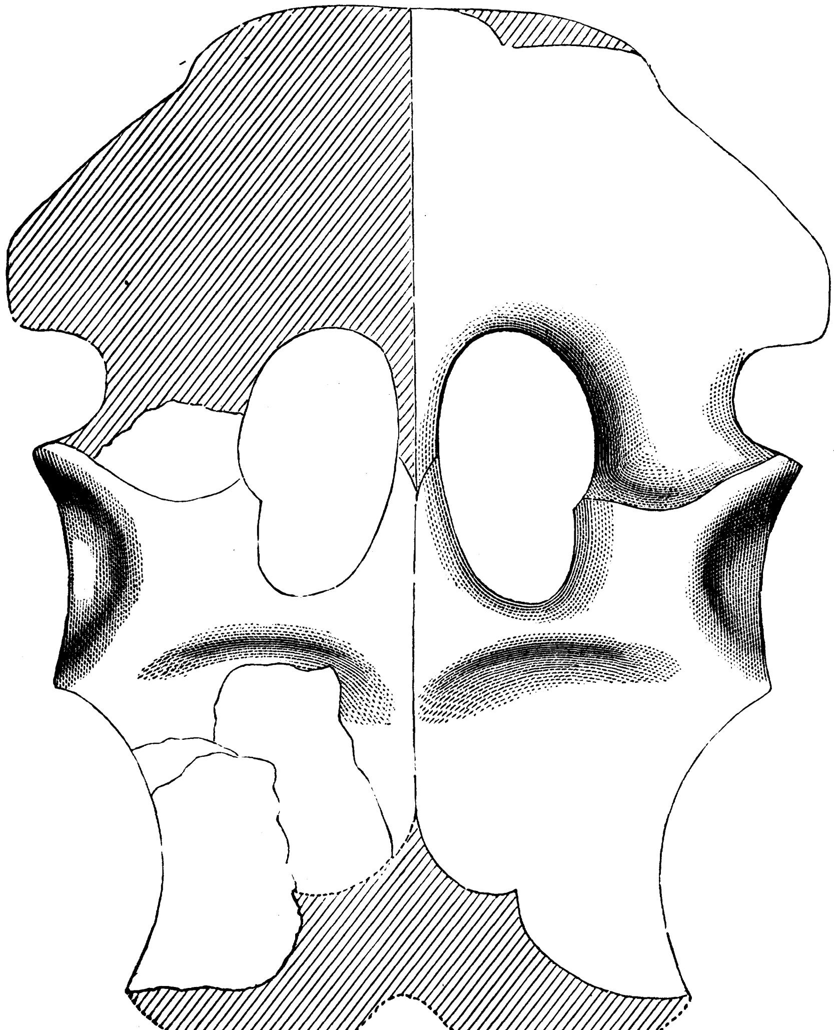
	In.	*Lin.*
Antero-posterior diameter of fourth caudal,	2	4
Transverse do.,	3	10.5
Total elevation,	8	
Vertical diameter centrum,	3	1.5
Anterior-posterior diam. diapophysial pit,	1	9.2
do. do. third cervical,	2	2.
Transverse do. do.,	2	11.

Heads of fourteen *ribs* are preserved, and a great number of shafts. The heads are simple, with elongate oval articular face. They are oblique in the narrow direction, and frequently in their length also; the margins are somewhat everted. The extremities of the diapophyses of the larger dorsal vertebræ are transverse, some flattened,

the others more oval, the more anterior are sub-triangular, and the rib pits on the first dorsals are sub-round or vertically oval. Thus the heads of the ribs also vary. The shafts are all flat, probably more so from pressure. They are frequently curved in the direction of the compression, which suggests a vertical head. They however are probably more or less distorted, and the plane of compression changed. No well defined distal extremity of a rib can be made out, nor have anything like abdominal ribs been preserved.

The *scapular arch* is remarkable for its large clavicles (or procoracoids). As preserved, the latter are quite convex downwards both antero-posteriorly and transversely, while the coracoids are equally concave in both directions.

Fig. 7.



Scapular Arch.

The clavicles have a remarkable external flat projection, which is separated from the glenoid cavity by a deep sinus. The glenoid cavity is bounded by an elevated ridge, which sends a branch along the claviculo-coracoid suture to the precoracoid foramen. This foramen is relatively of small size, and is a longitudinal oval; the two are separated by an isthmus composed equally of processes of clavicle and coracoid. The coracoids are very thin except in a transverse

portion, which extends across behind the precoracoid foramina; a strong elevated rib extends across the posterior face at this point. The outer margin of the coracoid is thickened, rounded and slightly concave.

	In.	*Lin.*
Greatest antero-posterior length scapular arch,	33	6.
" " " clavicle,	14	9.
" " " glenoid cavity,	6	9.
" " " precoracoid foramen,	7	3.
Transverse extent of claviculi,	27	
" " coracoidea,	16	
From acetabulum to foramen,	7	6.

The form of the posterior margin of the coracoidea is unknown, and they are much broken on the inner margin. They may have been considerably longer than in the accompanying cut.

The greater part of the *pelvic arch* appears to be preserved. From the obliquity of the median suture and from the form of the pubes as they are preserved on a large nodule of indurated clay, it is evident that they have formed a boat-shaped support to the abdominal viscera, with an obtuse keel on the median line below. The following diagram will explain the relation of its parts.

	In.	*Lin.*
Greatest antero-posterior length,	25	
" " " pubis,	13	6.
Antero-posterior median length to notch of ischia,	7	
Length coracoids behind notch,	4	6.
Greatest width pubes,	27	6.
" " ischia,	21	

The anterior and lateral portions of the pubes are very thin, as are also the median posterior portions of the ischiadic plates. The pubic bones are thickest on the posterior margin; they present a downward projecting median convexity near the anterior end. Depth of the articular face, 2 in., 8 lin.

The superior surface of this arch was brought to light by the exertions of my friends, B. Waterhouse Hawkins and Wm. M. Gabb, who removed a large mass of matrix which fortunately accompanied and protected it. This presents a transverse thickening extending across it, and continuous with the posterior margin of the clavicles. A median longitudinal thickening extends from this to the anterior emargination, embracing in its angle with the transverse, a shallow concavity. The posterior projection which is continuous with the median part of the ischia, is strongly deflexed behind the transverse rib, and is continuous with the basin-like concavity formed by the united pubes. The glenoid surface of the pubes is a sigmoid, while that of the ischia is regularly convex. The articulation of the ilium has been exclusively with the former.

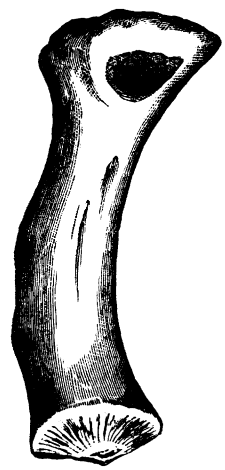
Of the pleurapophysial portion of the two arches nothing appears to be preserved except two lateral symmetrical long bones. One was found imbedded in the mass carrying the pelvic arch, and they articulate well with the pubes; but the articular extremity is too short to articulate with ischia at the same time. Though they resemble the inferior view of the procoracoids, they represent the ilia of Plesiosaurus. The head is subdiscoid, rather flat, slightly projecting excentrically with a ligamentous pit. The articular surface is very oblique to the axis of the shaft, and is separated from the surface by a marked angle all around. Nothing like a trochanteric ridge is apparent in this bone.

	In.	*Lin.*
Length in middle of curve,	9	9
Diameter at head,	3	3
" distally on curve,	6	
" " straight,	4	

Fig. 8.

Fig. 9.

Fig. 10.



Pelvic Arch.

The shaft is flattened cylindric; much flattened nearest the proximal extremity. The latter is very oblique to the shaft and slightly convex near the proximal margin.

The end of *the muzzle* preserved, includes also the symphysis and parts of the rami of the mandible. The parts have been crushed together, and the ends of the teeth broken off. The alveoli of the two jaws incline at a narrow angle to each other, hence the teeth which alternate, cross each other near the middles of the crowns. The parts preserved appear to belong to the premaxillary bone, though no suture can be found, and the bony walls are so thin as to render their obliteration a probability. There is a keeled ridge along the middle line above, which is not continued to the margin of the bone. The form of the muzzle is narrow, the sides subparallel near the tip, which is elongate rounded. The mandibular symphysis, however, is not very elongate, as the rami are given off at three inches from the tip. The latter appear to have been quite slender from various small sections or pieces sent with the muzzle, The premaxillary border of 4 in. 7 lin. exhibits eight teeth, or their alveoli, of which the median two are close together, and not separated by any mandibulars. The sections of the teeth are round or oval, and their sizes are irregular probably on account of differing age, and degree of protrusion: the diameters at alveolar margin vary from 6 lines to 3. Their form is slender conic, or with the root slender fusiform, and the pulp cavity is small and median,

sometimes cylindric, and somtimes narrowed. The surface from a short distance above the alveolar margins to the tip, is marked with acute thread-like ridges, which are sometimes interrupted, and sometimes furnished with short branchlets. They are more or less undulate, and do not unite, but simply cease as the tip of the tooth is approached. The latter is smooth without lateral cutting edges. The width of the mandible at the commencement of the rami is 3 in. .05 lin.; of the muzzle of the seventh tooth 3 in. 7.5 lin.; at the third tooth 2 in. 4.2 lin.

Fig. 11.

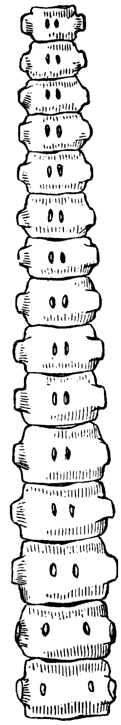
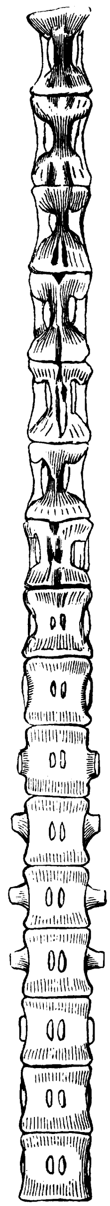


Fig. 12.



General Remarks.—The tail is a powerful swimming organ, more or less compressed in life, hence the specific name, which means flat-tailed.

The danger of injury to which such an excessively elongate neck has been exposed, would render the recovery of a perfect specimen like the present, an unusual chance. The neural spines of the dorsal region are so elevated and closely placed as to allow of little or no vertical motion of the column downwards, while those of the cervical and caudal region being narrower, the elevation of the head is quite possible, and an upward flexure easy.

The habit of this species, like that of its nearest known allies, was raptorial, as evinced by the numerous canine-like teeth, and the fish remains taken from beneath its vertebræ.

The general form of this reptile, whether it was furnished with large posterior limbs or not, was that of a serpent with a relatively shorter, more robust and more posteriorly placed body than is characteristic of true serpents, and with two pairs of limbs or paddles. It progressed by the strokes of its paddles, assisted by its powerful and oar-like tail. The body was steadied by the elevated keel of the median dorsal line, formed by the broad, high neural spines. The snake-like neck was raised high in the air, or depressed at the will of the animal, now arched swan-like preparatory to a plunge after a fish, now stretched in repose on the water or deflexed in exploring the depths below.

Differences from other Sauropterygia.—The only genus with which it is necessary to compare this present one is Cimoliasaurus. The following may be noted as generic distinctions: The series of cervicals rapidly diminishes in Cimoliasaurus in absolute size and in relative length of the vertebræ, which are not compressed. In the present genus they maintain a similar length for a considerable distance, diminish in length very gradually and are much compressed. The diapophyses of the dorsal vertebræ, as they descend, in Cimoliasaurus, continue well developed until they attain the inferior planes of the centrum, and have there a downward direction. In Elasmosaurus they cease while yet on the middle of the centrum, and are replaced by pits throughout the remainder of the length.

The neural canal is everywhere markedly larger in Cimoliasaurus.

As the characters of lesser significance may be added, that in Cimoliasaurus magnus the dorsals with elevated diapophyses are considerably larger in the centra than those in which they are situated lower down. In E. platyurus these vertebræ are of relatively equal length.

The cervical pleurapophyses in C. magnus are anteriorly considerably stouter and less flattened; the same applies to more anterior vertebræ, where they are flatter in both.

In comparing this species with the Cimoliasaurus grandis, Leidy, from Arkansas, we observe, first, the generic character of the strong inferior diapophyses in the latter. That species marks itself also as a preëminently short-necked form, as these anterior dorsals are even shorter than in C. magnus, being nearly twice as wide as long. The depth of the articular faces is also relatively greater than in the E. platyurus.

History.—The determination of the extremities of this species was rendered difficult from the fact that Leidy in his descriptions of Cimoliasaurus, reverses the relations of the vertebræ, viewing the cervicals as caudals and lumbars, and describing the caudals as belonging to another genus. Not suspecting this error, I arranged the skeleton of Elasmosaurus with the same relation of extremities, and the more willingly as the distal cervicals present an extraordinary attenuation, even for this type, and also as the discoverer assured me that the fragments of cranium were found at the extremity which is properly the caudal. Viewed in this light many details of the structure were the re-

verse of those ordinarily observed among reptiles, whence I was induced to consider it as the type of a peculiar group of high rank. This view is, of course, abandoned on a correct interpretation of the extremities. Leidy detected the error in this arrangement, and the correction extends to Cimoliasaurus as well.

ELASMOSAURUS ORIENTALIS, *Cope.*

This species is indicated by two vertebræ. The first resembles both the twelfth from the first dorsal of the cervical series of Cimoliasaurus magnus, or the fifth from behind, of the same of Elasmosaurus. Its large size, lateral longitudinal angle and small neural canal refer it with more probability to the latter genus. It appears to belong to a species possessing some of the peculiarities of the Cimoliasaurus magnus, having the quadrate form of the median cervicals of that animal, and lacking entirely the compression of the centrum and lateral concavity of the E. platyurus. The parapophyses are stronger and slightly more descending than in the fifth cervical of the latter, again resembling the more posterior vertebra of C. magnus Leidy. The bases of the parapophyses are more elongate than in the corresponding vertebra of C. magnus; the process was directed downwards at an angle of 45°, from the plane of the inferior aspect. The inferior plane is slightly concave, with two venous foramina, each in a strong groove on each side of a narrow median rib. The lateral surface is nearly vertical and slightly concave to the strong longitudinal angle. Above the latter the face is oblique concave for a width equal to that below. The articular faces are transverse ovals and slightly concave; their margin not prominent, nor ribbed on the lateral faces.

	Lines.		*Lines.*
Length,	45	Width canal,	7.7
Width,	52	Length basis of parapophysis,	25.
Depth to canal,	36		

If we estimate this vertebra by the position of the lateral ridge to be about the eighth anterior to the last rib-bearing, which I call cervicals in this genus, the transverse diameter of this vertebra in C. magnus is two-thirds that of a dorsal with diapophyses near the middle of the centrum. Should the proportions have been similar in this species, the diameter of that dorsal would measure 6½ inches, indicative of the largest of American saurians. As, however, in the genus Elasmosaurus the disproportion between the sizes of the caudals and the dorsals is less than its ally, the latter have probably presented a diameter more like the same in E. platyurus.

A second vertebra from near the same part of the column of a much larger individual was obtained by Dr. Samuel Lockwood, superintendent of schools of Monmouth County, N. J., from Wm. Conovers' pit in the lower bed, near Marlboro, in that county. The diapophyses are directed downwards at an angle of 45°. The margins of the articular faces are not everted, while the inferior presents an open emargination medially. The two inferior foramina are very large. The measurements are as follows:

	In.	*Lin.*
Width of articular surface,	5	9
Depth do. do.,	4	3
Length centrum,	4	6

The name is not given under any supposition of restricted habitat, which may have been similar to that of the E. platyurus, but in view of the probability of its greater abundance where its remains have been found than elsewhere.

Our knowledge of this species is unfortunately confined to the two vertebræ above described. The first is from the lower cretaceous greensand bed, from near Swedesboro, Gloucester County, New Jersey. It was found in a tailor's shop used as a block to secure a door.

Incertae sedis.

PIRATOSAURUS, *Leidy.*

PIRATOSAURUS PLICATUS, *Leidy.*

Cretaceous Rept. N. Am., 29, 30, Tab.
Cretaceous of Red River Settlement, Lat. 49 deg., Northern Minnesota. Described from a tooth.

THECODONTIA.

Owen in part.

In this suborder we have a singularly generalized group, combining characters of lizards, crocodiles and Sauropterygians. The neural arch of the vertebræ united by suture and the slightly biconcave centrum, resemble the last two, so also the abdominal ribs. The limbs are rather crocodilian, the position of the nares, Plesiosaurian. The clavicle is lacertian, while the three vertebræ of the sacrum and the femur are between these and the Dinosauria.

The most important characters distinguishing these animals from the Sauropterygia are the presence of an elongate sacrum and the more ambulatory form of limbs.

Our knowledge of the order is almost confined to Belodon Meyer, and is derived from that author's descriptions of those large and remarkable reptiles derived from the Keuper of Würtemburg, the Belodon kapfii Meyer, B. plieningeri Münst., and B. planirostris Meyer.

The American species of the order are known only from the valuable collections made by Wheatley at Phœnixville, Pa., and by Emmons at Deep River, in Chatham county, in North Carolina. The former are in my hands for examination and description, and will be the subject of an appendix to this work.

BELODON, *Meyer.*

Although this genus does not present the swimming extremities of Plesiosaurus and Nothosaurus, its structure in this respect is not much more different from them, than that of the marine turtles is from the terrestial families of the same order. The structure of the sphenoidal region, the peculiar position of the external nostrils, almost above the orbits, with the rhizodont dentition, are points in which they agree. The position of the exterior nares cannot be regarded as an ordinal character, since we see what remarkable differences of position it exhibits in the existing family Varanidæ. There is is every probability that these animals were aquatic. The posterior position of the nostrils, like that in many other marine animals, enabled them to plunge the long muzzle beneath the surface of the water or mud without interfering with respiration.

The dentition of the posterior parts of the mouth has been shown by Von Meyer to be quite different from that of the anterior regions; the latter are prehensile, that is elongate conic, the former cutting, *i. e.*, flattened, broader and with trenchant edges.

On teeth of the latter kind Emmons established his *Palæosaurus carolinensis* and *P. sulcatus*; and Leidy, *Compsosaurus priscus* and *Eurydorus serridens*. On teeth of the former kind Emmons based his *Clepsysaurus pennsylvanicus* in part; his *Rhytidodon carolinensis* and *R. sulcatus;* Leidy's *Omosaurus perplexus* and Lea's *Centemodon sulcatus* had a similar origin. The names based on the lenticular teeth accompany, as prior to, or synonymes of, the latter series. There is much difficulty in collating them, but I may follow Emmons at present, in seeing in the two styles of smooth and fluted teeth, those representing different species.

In this way I have attached to the fluted toothed *Rhytidodon carolinensis*, Emmons, the *Palæeosaurus sulcatus* of the same author. Emmons does not offer any grounds of separation for his *R. sulcatus*, nor Lea his *Centemodon sulcatus;* neither can I find aught in Leidy's *Omosaurus perplexus* by which it can be separated. Leidy represents it to be an "Enaliosaurian," while Emmons says (North American Geology, 67–79–82), that it is the same as his *Clepsysaurus* and *Rhytidodon*, citing Leidy as authority for this close approximation. If this be the case, the form is a shore-loving Belodont, and not nearly related to the marine reptiles included under the old name of Enaliosauria.

To the smooth toothed type belong posterior teeth named by Emmons, *Palæosaurus carolinensis*, and by Leidy, *Compsosaurus priscus* and *Eurydorus serridens*, and anterior teeth referred, erroneously in part, as I believe, to *Clepsysaurus pennsylvanicus*, Lea. The first mentioned name cannot be used, as it has been already applied to a member of this genus. The third was based on a specimen from a very remote locality, and its proper application remains uncertain. The second specific name may be employed in the uncertainty, though its describer included both fluted and smooth teeth in the same species.

Specimens in the Academy Mus., from Montgomery Co., N. Ca., consist of vertebræ, tarsal bones, etc., and parts of cranium with dermal bones of this species. A tooth in place in the extremity of the ramus of the mandible, is as smooth as those from more posterior positions in the jaw, figured by Emmons, N. Am. Geol., p. 69, fig. 42, which in some measure supports Emmons' hypothesis of the uniformity of the characters of the surface sculpture. The cranial fragments indicate a Belodont, and the vertebræ are different from those of Clepsysaurus.

The vertebræ, (No. 5) from the coal of Chatham Co., N. Ca., were accompanied by teeth of the fluted character, though they were not on the same block. As the former indicate a species distinct from that from Montgomery Co., I have regarded them as probably pertaining to Emmons' *Rhytidodon carolinensis.*

The remains, (No. 6) from Phœnixville, include vertebræ, bones of the pelvic arch and posterior limb, with dermal bones, but no teeth. They indicate an animal distinct from either of the preceding.

Emmons describes a species *Clepsysaurus leaii*, from the coal strata of Dan River, from near Leakesville, N. Ca., which appears to be distinct from the *Rhytidodon carolinensis*. It is represented by a cast of a block of sandstone containing 14 vertebræ, etc., which indicate a species different from any of those above mentioned.

Finally, although the *Eurydorus serridens*, Leidy, from its locality (Phœnixville, Pennsylvania), may indicate a fifth species, there is nothing in the type specimen, nor in the description, to determinine any reference. It cannot safely be regarded as the same as the Belodon here described, from the same locality, since the strata in which the two occur, are separated by a vertical thickness of 187 feet of rock.

Having satisfied myself of the existence of four distinct species of Belodonts in our Triassic beds, their generic relations come next in order for consideration.

In his Manual of Geology, Prof. Emmons figures the cranium of a Reptile (fig. 157, page 179), which bears a near resemblance to that of the Belodon plieningeri, Meyer. The cast of this cranium in the Museum of the Academy Nat. Sci., confirms the reference to this genus, and presents no characters by which it can be distinguished from it. The specimens (No. 4) consist in part of the short frontal bones with part of the orbits and cranial cavity, and a portion of the ramus of the mandible, of a saurian near the genus Belodon, perhaps the same. The ilium figured by Emmons (N. Amer. Geology, p. 77, fig. 47,) and the femur, (fig. 48), with portions of mandibular ramus (fig. 42), obviously indicate Belodonts.

Of the Phœnixville saurian, portions of the ilium and ischium are preserved, which indicate that the animal is neither a Dinosaurian nor a Dicynodont, nor yet a Crocodile. The portion of ilium answers to that of Belodon, as figured by Meyer and Emmons.

The Dan River species is referred to the same group without entire certainty. The only teeth occurring in the same strata are, according to Emmons, identical with those of the smooth toothed Belodont from Deep River. The cervical vertebræ are quite similar to those of the Deep River species.

I can as yet find no generic characters by which to distinguish these species from the Belodon of Meyer, neither in the cranial, dental, pelvic nor extremital regions. Meyer describes and figures numerous teeth, both smooth and sulcate, without distinguishing the two forms specifically, though it is certain that three species of the genus came under his observation. He figures ilia of two species, one of which cannot be distinguished generically from that figured by Emmons (l. c. fig. 47).

This genus was referred by Owen to the *Thecodontia*, along with some other little known genera. Some of the latter, especially Bathygnathus and Clepsysaurus, are in our opinion Dinosaurian, while others, as Belodon, represent a family of the present order.

BELODON CAROLINENSIS, *Emmons*, *Cope*.

Proceed. Ac. Nat. Sci., 1866, 249. *Rutiodon* (*Rhytidodon*) *carolinensis* Emmons' N. Amer. Geology, p. 82. Geol. Surv. North Carolina. *Palaeosaurus sulcatus*, Emmons loc. cit. (posterior maxillary teeth), Fig. Emmons Manual of Geology, p. 179. *Centemodon sulcatus*, Lea. Proceed Ac. Nat. Sci., Phila, 1856, 78. Cope, 1868, 221. *? Omosaurus perplexus*, Leidy, Proceed. Ac. N. Sci., Phil., 1856, 256.

This reptile I find on examination of the type specimen to belong here. Teeth of the same are in Wheatley's collection at Phœnixville. I do not consider that any ground of specific distinction between this animal and the *C. sulcatus* has been pointed out, but leave the discussion of the relations of these Triassic forms for a future essay.

Lea has called my attention to the fact that through some error in reading the scale, the measurements of the type tooth published are double the correct ones. The specimen consist of the distal half of a slightly curved conic tooth, and does not display any pulp cavity; the allusion to this in the original description having reference to fracture. The tooth cannot be called sulcate, but is rather weakly ridged or fluted. The original description may therefore be amended to read thus:

Tooth slightly curved, with low trenchant edges, rounded on the exposed face, openly fluted on the lower (median) portion near the fracture, covered with very minute distinct striæ from the point to the base, which striæ cross to the flutings in oblique lines. Length, eight-twentieths of an inch; greatest breadth, two-twentieths; pulp cavity minute or none.

The enamel of the teeth of B. carolinensis is rarely preserved; when this is the case its striæ, fluting, etc., are as ascribed in C. sulcatus.

Coal Measures of the Keuper Trias. Chatham Co., N. Carolina.

BELODON PRISCUS, *Leidy*.

Palæosaurus carolinensis, Emmons, Geological Survey N. Ca., 1856, p. 80. N. Amer. Geology, 1857, 86, figs. 57–8 60. nec *Rhytidodon carolinensis* supra. *? Compsosaurus priscus*, Leidy, Proc. Acad. Nat. Sci., Phila., 1856, 165. *Clepsysaurus pennsylvanicus*, "Lea," Emmons in parte, Geol. Survey N. Carolina, 1856; North Amer. Geology, 1857, pp. 67–71–3; figs. 37 to 50 nec Leaii.

Represented by numerous specimens from the Triassic of Chatham and Montgomery counties, N. Carolina. Teeth not fluted; caudal vertebræ with articular faces broad as long, and centrum little compressed. Size medium.

BELODON LEAII, *Emmons*.

Clepsisaurus leaii, Emmons, Geol. Survey N. Ca., 1856; N. Amer. Geology, 1857, p. 79, fig. 51, Pl. 8, figs. 1–4.

Emmons states that this species is smaller than the last, and that the centrum is longer than broad. Cervical vertebræ short, compressed, extremities strongly concave. The Trias of Dan River, N. Carolina.

BELODON LEPTURUS, *Cope*.

Spec. nov.

Represented by wholes or parts of fourteen vertebræ; a left femur and fibula; a phalange; imperfect ilium and ischium attached; with numerous ribs and dermal bones, from several blocks of bituminous shale from the bone bed in the tunnel at Phœnixville, Penna.

The fragments indicate the largest species of the genus, one of the vertebræ with spine, measuring eight inches in total elevation. The centra of the dorsals are wider at the articular faces than long; in the other two species the length is greater than or equal to the width. The caudal vertebræ are much compressed, not subcylindric as in B. priscus. The femur restored measures thirteen inches in length. Ischium sending a process forwards bounding the acetabulum below in part, largely excavated by the obturator foramen, which is very externally situated.

The bones were enclosed in five slabs of black, bituminous argillaceous rock of the Phœnixville section, and they were taken out from the same immediate proximity by the workmen engaged in the work in the tunnel. One slab contained three dorsal and two caudal vertebræ with chevron bone. The second, one and part of another dorsal ver-

tebræ and the head of the femur; the third a nearly perfect vertebra and diapophysis of another, with dermal bones; the fourth the greater part of the femur, with fibula and dermal bones; fifth, ribs and dermal bones, with pelvis.

Seven *vertebræ* present centra, and are more or less nearly perfect. There are probably no cervicals, but there are three forms of diapophyses which indicate different positions in the vertebral column.

That which I suppose to represent the most anterior, has a short, wide diapophysis with tubercular articular surface, and a short knob with capitular articulation at the base of the anterior aspect of the neurapophysis, with its superior margin on the plane of the diapophysis. In the next, the diapophysis is short, wide, and closely connected at the base with a capitular articular tubercle, for the rib, the extremity of the diapophysis furnishing the tubercular surface. In the first of these the diapophysis is as long as the elevation of the anterior zygapophysis above the centrum, and the capitular knob measures the middle of the latter space with its superior margin, being in the plane of the diapophysis. In three others the elevated position of the capitular articulation is visible. The second form of diapophysis is seen in a nearly perfect vertebra in immediate connection with that first described above, but probably in abnormal relation. The process is narrower, but flat, and without capitular process at base, nor is there any captular articulation on the centrum. Its position is much lower than in those just described, being opposite to the middle of the centrum. Its extremities are imperfect, probably broken off. I suspect that their condition is indicated by an isolated diapophysis, which is accompanied by tubercular articular face at a distance of 18 lines from its extremity, and probably at some distance from its base, which is, however, lost. The third type of diapophysis is seen in two examples; one, in normal relation to its centrum, etc. This is quite slender and elongate, compressed at base, and cylindric throughout most of the length. On the posterior face of the extremity is a slightly concave articular face; the extremity proper appears also to have borne the tubercular face. That these are the combined tubercular and articular facets is rendered altogether probable by their wider separation on the second example of this form. This is an isolated diapophysis, of slender cylindric form, which, at a distance of an inch from the extremity dilates into a right-angled flat process, whose distal side bears a narrow capitular articular face. The extremity is subcylindric, bearing the tubercular facet.

This arrangement of the vertebræ is confirmed by the arrangement seen in other species, where vertebræ similar to those first described are evidently dorsal. It is probable from the above, that the capitular articulation rises from the centrum very soon in this type, as in the Crocodilia, perhaps very few dorsals retaining it on that portion; and differing from the Dinosaurian type, where this facet is on the margins of the centra and not elevated on a pedicel. This form differs from the Crocodiles in the narrowing and final cylindric form, as well as descent on the centrum of those diapophyses on which the two facets approach and unite.

One objection to the position assigned to the last form of vertebra, is the fact that the only one with perfect centrum presents an oblique truncation on the posterior margin on each side, which looks much like a capitular articular face. There is a precisely similar vertebra in the Museum of the Acad. Natl. Sciences, from Chatham Co., N. Ca., which is ascribed to the B. carolinensis. Their surface is concave in this specimen, but seems too large for the head of a rib. In both, the vertical diameter is one-half the transverse width of the articular face of the centrum. I cannot assign the place or use of this facet with certainty, but the following light is thrown upon the point by another specimen in the Museum Academy, also from Chatham Co., N. Ca., presented by Prof. Emmons.

It consists of five consecutive vertebræ on a block of coal slate, of which the anterior two present the capitular tubercle elevated to the base of the short flat diapophysis, without being confluent with it in the first, but closely united to, and of equal length with the shortened second. On the third, the rib-diapophysis becomes abruptly very much wider, and occupies a position a little lower down on the centrum. The diapophysis is preserved on one side of the block. It is flat, a little narrowed beyond the middle, then dilated, and with an open emargination opening posteriorly and outwards, at the distal extremity. With the extremity it bears a narrow articular surface. These I suspect to represent capitular and tubercular articulations. The fourth and fifth vertebræ bear each, a greatly dilated and thickened diapophysis, which I have little doubt represent the sacral supports of the ilium. Their expanded bases are somewhat lower in position than the diapophyses of the vertebra in advance, and they occupy a broad articular face of their proper vertebra, and a distinct facet of that preceding, leaving an articular face on its posterior margin. I suppose the peculiar vertebræ already alluded to in the B. lepturus and specimen from North Carolina, are, therefore, the last lumbars.

From the above, four points may be derived: 1. That the ribs are continued to the sacrum in this type, a character not before pointed out among its representatives in this country or Europe, and one in which it differs from the Crocodilia from the Cretaceous to the present period inclusive. 2. That the sacral diapophyses articulate with two vertebræ instead of one, a point similarly exceptional with the last point. 3d. That in both these points this type approaches the Dicynodontia and Dinosauria, as it does in some others. 4th. That the B. lepturus belongs to a different species from that from N. Carolina, last described, in having at least three diapophyses with double articulation near the extremity instead of one, and to a different genus from the same, because several of these are cylindric in the former, and broadly flattened in the latter.

Which genus is distinct from Belodon is difficult to ascertain. If we suppose B. carolinensis to represent it, as it certainly does in cranial characters and other respects, the North Carolina specimen will represent another genus, since a sacral vertebra of B. carolinensis presents all the characters of that of B. lepturus.

The centra of the vertebræ are very much compressed, and the articular faces flared out at the margins. The faces are wide vertical ovals and distinctly concave. The posterior face of the supposed last dorsal is flattened, and presents two slightly swollen triangular planes, each from the facet of the margin.

The neural spines of the anterior vertebræ are shorter and wider, of the posterior more elevated and narrower. The rib supporting the anterior zygapophysis is very prominent in all, as is that defining the margin of the neural arch. They include a short vertical concavity between them, giving the vertebræ a marked character.

The caudals are very much compressed, more so than in B. ? priscus, though since they are median in the series, and those of the latter are proximal, there would probably be a greater resemblance between the homologous ones. The articular extremities are vertically oval, and but little flared at the margins. The neural arch with its apophyses is compressed. The diapophyses project just below the base of the arch, and are depressed and stout.

Measurements.	*M.*
Vertebra 1st type,	0.18
Do. height neural spine from canal,	0.10
Do. length diapophysis,	0.026
Do. " centrum,	0.05
Do. diameter centrum middle,	0.021
Do. " " articular face,	0.055
Do. " " vertical, articular face,	0.059
Total elevation type 2d,	0.1951
Do. neural spine from canal,	0.122
Do. width do.,	0.04
Do. length centrum,	0.05
Do. diameter (transverse) centrum middle,	0.023
Do. " " " artic. face,	0.054
Do. " vertical " "	0.06
Do. elevation type 3d,	0.186
Do. neural spine from canal,	0.11
Do. length centrum,	0.049
Do. diam. (transverse) centrum at middle,	0.032
Do. " " " artic. face,	0.061
Do. " vertical " "	0.062
Do. expanse anterior zygapophyses,	0.07
Do. diameter neural canal,	0.02
Length diapophysis,	0.082

The neural canal in the vertebra first described, is narrower and more elevated than in the last dorsal.

A *chevron bone* has nearly cylindric limbs and short common junction of the same. Their proximal extremities are considerably expanded, but not so as to meet on the median line. They are very oblique backwards and inwards. Distal extremity strongly striate.

	M.		M.
Length,	.075	Inner,	.005
Proximal expanse, outer measurement,	.052		

The portion of the *pelvis* preserved consists of the proximal halves of left ilium and ischium, the anterior portion of the latter being broken away. This fragment is not Dinosaurian; the longitudinal expansion forbids the reference of the ilium as the ischiopubis of a Dicynodont, and the ischium is too different to be regarded as the scapula of a Belodont. It presents a broad shallow concavity as acetabulum, which on the inner face is grooved and ridged at the inferior margin, as though united to the ischium by suture. This is well shown in Emmons' figures of the same bone of another species, in North Amer. Geology, Pl. VI. The upper plane of this element is abruptly curved backwards and then broken away. The supposed ischium presents a marked acetabular articular face at its posterior connection with the ilium. Its posterior margin is much thickened, and becomes decurved towards the symphysis, which is lost. It sends a limb anteriorly along the line of union with the ilium, and apparently terminates in a narrow obtuse extremity with rugose margins. Its supposed obtruator margin is thickened along this process; the main body of the bone is flattened at a strong angle with the posterior margin, and turned away anteriorly like the ilium of a Dicynodont, and includes an incomplete oval foramen with the acetabular process. The two pelvic elements are crushed nearly into one plane.

	M.		M.
Length of fragment,	0.167	Width ischium at foramen,	.055
" ilium to posterior process,	.0715	Thickness " distally,	.021
" iliac suture of ischium,	.092		

The mode of attachment of the pubis is not indicated in this specimen, but it was evidently quite different from that in the Crocodilia.

The *femur* is that of the left side; it is perfect, except that the portion usually supporting the third trochanter is broken out; say two inches. The head is Crocodilian, *i. e.*, without neck and compressed in one plane. Its extremity is slightly convex inwards, the inner extremity thickened, convex and decurved; the extero-posterior thinned and curved backwards slightly. The margin continued from the latter is therefore thinned, though obtuse edged, and encloses a wide shallow groove with the inner, thickened margin. There are no distinct trochanters. The shaft is quite slender, obliquely spherical triangular in section, with an inner ridge in front, and outer behind. The medullary cavity is very small. At the distal third the shaft is flattened antero-posteriorly. The trochlear groove is wide and shallow, and the condyles project less posteriorly than is usual; they have, however, been under considerable pressure. The inner is wider and shallower, the outer narrower and deeper. Their extremital faces are separated by an open notch.

The *fibula* is a long slender bone, having a slight sigmoid flexure, and ridges twisted round the flattened shaft. The extremities are more flattened, both in the same plane; the proximal is broken away; the distal is obtuse, one end terminating in a point; the surface rugose. Its form is Lacertilian.

	M.		M.
Length femur, restored,	0.34	Diameter condyles, inner, fore and aft,	0.045
Diameter head, antero-posterior,	0.09	Length fibula, broken,	0.24
" " transverse (greatest),	0.044	Diameter perfect extremity,	0.035
" shaft at middle,	0.045	" imperfect "	0.042
" condyles, transverse,	0.083	" shaft,	0.025

What is doubtfully referred as a distal *phalange,* resembles that ascribed to a species of the genus by Meyer, but as I cannot find lateral grooves, and the proximal articulations are concealed by matrix, it may not be such. One lateral margin is obtuse, the other acute; body thinned out to tip, flat in cross section below, concave in longitudinal, as wide distally as proximally.

	M.		M.
Length,	.035	Depth proximally,	.0165
Width distally,	.017		

Surface striate-rugose; lines of the upper surface converging toward a median point from the base.

Several more or less broken, and one complete *rib* are preserved. The two heads are distinct. The perfect rib

is perhaps a posterior dorsal. It is but slightly curved, has a vertically broad oval section proximally, and a depressed trigonal one distally; there is little trace of a medullary cavity.

	M.		*M.*
Length,	0.23	Vertical diameter at distal third,	0.014
Do. from head to tubercle,	0.03	Transverse do.,	0.155.

I find no abdominal ribs, such as are abundant in the North Carolina specimen described on a preceding page.

This species has been distinguished from B. priscus by the form of its caudal vertebræ. The measurements given by Emmons and Leidy, of the other species, differ in the greater elongation of the vertebral centra. The length of the latter is in each case greater than the width of the articular face, instead of less. They are also smaller in all their dimensions. We shall not go very far wrong in estimating the length of this species on the basis of the gavial of the Ganges, as furnished by Cuvier. This would give to the Belodon lepturus a length of about ten feet, and a habit stouter than that of the Crocodiles of the present day.

This species was discovered by Chas. M. Wheatley, proprietor of the lead and zinc mines at Phœnixville, Penna. He obtained the remains from the "Bone bed" of the Trias, where exposed by the Phœnixville Tunnel of the Reading Railroad. This stratum is, according to Wheatley, 6 ft. 6 in. from the top of the series; 52 ft. 6 in. lower down is a stratum rich in plants and Saurian remains, and 95 ft. deeper occur bituminous shales with caprolites and bones.

CROCODILIA.

The constitution of the cranium in this order is very characteristic and peculiar. The basal cranial bones are forced backwards, so that they occupy a more or less vertical position, and the sphenoid is almost concealed in many. The quadratum is immoveably embraced by the exoccipital, proötic and opisthotic. The pubes do not enter into the walls of the acetabulum as in Mammalia and Reptilia, but originate from the inferior pelvic arch. They form no common suture, but extend sub-longitudinally, thus differing from pubes generally. The latter relation of true pubes occurs among Reptiles only in Chelys, Pelomedusa galeata, and Sternothærus, among the Chelonia, and in Pterosauria. An anterior process from the ischium occupies the usual position of the origin of the pubis, as a support for the latter.

There are at least two well marked types in the class, defined as follows:

Vertebræ procoelian, *i. e.* with anterior cup and posterior ball; the sphenoid bone little visible on the base of cranium.

PROCOELI.

Vertebræ concave or nearly plane at both extremities; sphenoid bone with larger and more horizontal exposure on base of cranium.

AMPHICOELI.

The only genus of Amphicœli known in this country is Hyposaurus; the Procoelian genera are the following:

A The teeth composed of several enclosed cones of dentine.

a The cervical vertebræ with very rudimental or split hypapophyses.

A large fossa or foramen issuing between the prefrontal and lachrymal bones of the face; muzzle long, slender, teeth equal.

THORACOSAURUS.

No facial foramen; muzzle long slender.

HOLOPS.

aa The cervical vertebræ with long simple zygapophyses.
Muzzle long narrow, with long symphysis; teeth very unequal.

THECACHAMPSA.

Muzzle broad short, symphysis short.

PLERODON.

AA Teeth crowns a single dentinal cone with enamel sheath.
Cervical hypapophyses rudimental; muzzle broad.

BOTTOSAURUS.*

Cervical hypapophyses elongate, simple.

EXISTING CROCODILIA.

Species of this order have been abundant in North America from the beginning of the Cretaceous period to the end of the Miocene. At present they are confined to its extreme southern regions.

The Cretaceous period was more prolific in them than any later one, for then the Reptilian type in all its representatives reached its fullest development in the numbers, variety and size of its members. Then our sea coasts, estuaries, and fresh waters swarmed with them, an indication of the prolific lesser life on which they preyed or otherwise vented their powers of destruction.

THECACHAMPSA, *Cope.*

Proceedings Academy Natural Sciences, 1867, p. 143.

This genus was characterized from a few teeth from the Miocene of Maryland. Since then additional material has enabled me to construct its characters more fully.

Muzzle elongate, slender, as in Gavialis, the symphysis of the mandible elongate; dental series interrupted by larger canine-like teeth. Dentine of the crown arranged in concentric cones. Enamel thin, with a delicate anterior and posterior cutting ridge near the tip of the crown. Cervical hypapophyses elongate, simple.

The concentric structure of the dentine in this genus is quite the same as in Thoracosaurus. I do not discover in it sections of the teeth of Gavialis, Mecistops and Crocodilus. The cones readily separate and fall out in the fossil specimens. Their existence would indicate a periodical cessation of activity in the secretory vessels on the wall of the pulp cavity of the teeth, with intervening increase of deposit of dentine. In a shed tooth of this genus four such cones may be counted.†

*Probably the thin crown in this genus is composed of several attenuated cones.

†A supposed affinity of this genus to Mosasaurus, which I inserted in the original description, at the suggestion of a friend, I do not now recognize.

This genus presents the same peculiarity of dentition as the Plerodon Meyer (*Diplocynodus* Pomel) of the European Miocenes. The P. plenidens, and P. ratelii are both of the Crocodilian type of cranium, the rami of the mandible with curved extremity and short symphysis, while Thecachampsa is a gavial, with very long symphysis and slender muzzle. I have seen but one cervical vertebra from American tertiaries, and that is of the type of Thoracosaurus; hence this character cannot be *certainly* ascribed to Thecachampsa.

Three species appear to exist in our Miocene beds. The T. sicaria indicates in its slender mandible one character of the genus; it shows the surface to have been ridged and pitted as in other Crocodilia. The T. antiqua Leidy indicates in its dorsal vertebra, a smaller hypapophysis than in the known species of Crocodilus. T. sericodon Cope is only known from its teeth. The teeth of the three species may be thus distinguished. It must be mentioned that I have but one tooth of T. sicaria, three of T. antiqua and six of T. sericodon. In the first the tooth has a lenticular section a short distance below the tip, owing to the great development of the lateral cutting ridges, and the compression of the crown at their bases. In the other two, these ridges are much less developed; in T. antiquus they exist only towards the tip on the inner or concave face of the tooth, while in T. sericodon they extend more than half the length of the crown towards the base, on the inner side.

THECACHAMPSA SICARIA, *Cope.*

Proceed. Ac. Nat. Sci., Phila., 1869, 8.

This species is represented by a lumbar vertebra, an imperfect crown of a tooth, and a portion of the under jaw. They were submitted to me by Philip T. Tyson, State Geologist of Maryland, who procured them from near the mouth of the Patuxent River, along with the remains of Eschrichtius, Physeter, and other Cetacea.

The portion of mandible indicates an animal of a size considerably exceeding both the Gavial of India and the Thoracasaurus of the Cretaceous of this country. It contains all or parts of alveolae of six teeth. Opposite the fourth alveolus from the front, the margin diverges slightly from the median line, indicating the position of the distal extremity of the splenial bone. The slight degree of this obliquity indicates an extensive contact of these elements, and not a symphysis formed merely by union of the dentary elements as in Mecistops and Crocodilus. As no curvature appears at the anterior extremity of the fragment, and the alveolae are similar to those succeeding, it has evidently not been broken from the anterior portion of the symphysis. The nutritious canal of the ramus is thus nowhere exposed, but is enclosed in the long symphysis.

The upper face of the ramus is convex, most so anteriorly. Its lateral and inferior face is more convex than in other Gavials which I have noticed, especially posteriorly. Its surface is coarsely sulcate, and with numerous small foramina. A larger space than elsewhere is seen between the two median alveolæ, which is occupied by a deep concavity for the reception of a large tooth of the maxillary series. This indicates an irregularity in the size of the teeth of that series, as in the Crocodiles, and not an equality as in other Gavials. On placing the fragment in position the teeth are seen to have diverged at an angle of 45°.

The specimen had laid sufficiently long in the Miocene ocean bottom to have been fixed upon by barnacles and oysters, as a place of abode. That it had not remained unburied very long is evident from the small size which these parasites had attained ; and that it was buried in Miocene deposits and not worn by a more modern sea, is testified to by the Miocene shells (Turritella, etc.), whose fragments were removed from its cavities with the sandy clay of its place of burial. The teeth have been broken off in this rough contact with the elements, but I procured a large and characteristic portion of the crown of a successional tooth whose apex had attained to the level of the edge of the

alveolus, and whose development had occasioned the absorption of half the fang of the functional tooth. On the basis of this tooth I am enabled to determine the distinctness of this crocodile from the T. antiqua. The crown, instead of being like that species, a cone with a circular section, with a narrow cutting longitudinal ridge rising abruptly from the surface on each side, in this tooth has a lenticular section, with the cutting ridges on the acute opposite angles. The external face is strongly convex, though not so much so as in T. antiqua. The edges are crenate, but not so as to produce a serration of the margin. Enamel finely obsoletely striate.

The vertebra preserved is a posterior lumbar. The entire coössification of the neurapophysis indicates that the animal is adult; their upper portions are lost. The diapophyses have had an oblique basis, rising anteriorly, their middle being opposite the plane of the neural canal, the whole length standing on the anterior two-fifths of the length of the centrum. The cup is subcircular, wider transversely; the centrum is depressed; below broad, with a median longitudinal concavity; sides vertical. As compared with the dorsal vertebræ of T. antiqua, the latter are much more compressed in the centrum; and although the posterior lumbars are always more depressed than the dorsals, yet the present seems too much so to have pertained to the same species. It differs from those of T. antiqua also, in that the floor of the neural canal is entirely plane and smooth; in the latter it is deeply grooved, in consequence of the non-coalescence of the expanded bases of the neurapophyses.

	Ft.	*In.*	*Lin.*
Length fragment of mandible,		8	4.
Diameter of alveolus,			11.
Axial width from margin alveolus to symphysis above,		1	4.
do. do. do. do. below,		2	8.
Greatest width to median line (behind),		3	3.
Long diameter crown, at middle of length,			8.
Width muzzle,		2	8.
Estimated length cranium,		69	5.
do. total length,	33	4	
Length lumbar vertebra (centrum),		3	10.5
Width cup,		2	3.5
Height cup,		2	0.8

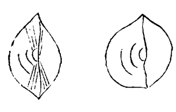
The above estimate of length is based on the proportions of the Gavialis gangeticus as given by Cuvier.

THECACHAMPSA ANTIQUA, *Leidy sp.*

Crocodilus antiquus, Leidy. L. c. 1851, 307. Journ. Ac. N. Sci., II., 135. Tab. *? Thecachampsa contusor*, Cope. Proc. A. N. Sci., 1867, 143.

This species continues as yet to be represented only by the specimens on which it was based, viz., two teeth, two vertebræ, an ungueal phalange, and a rib. These indicate a large species; the vertebræ are even larger than that of the last, and the teeth will not enter its alveolae. It is probably the largest of the known Crocodiles of this country.

Fig. 16.



B *A*

I have noticed only two dentinal cones in the two teeth we possess.

The accompanying outlines are those of sections of the teeth of the present species, and the T. sicaria C. Fig. A represesents the former and fig. B the latter.

The peculiar form of the tooth on which *T. contusor* was based, is due I find to attrition and partial destruction of the enamel.

"Eocene" of Eastern Virginia from the banks of the Potomac.

THECACHAMPSA SERICODON, *Cope.*

Proceed. Acad. Nat. Sci., Philad., 1867, p. 143.

This species was established on fragments of three teeth from the Miocene of Maryland. Four additional and much more perfect teeth, with fragments of jaws, from New Jersey, presented by my friend, Dr. H. C. Wood, Jr., elucidate the characters of both species and genus.

The most perfect tooth is slender and curved, and bears much resemblance to those of Holops obscurus. The section of both root and crown circular, the latter regularly acuminate, and furnished with delicate cutting ridges. Terminal half smooth, basal half with a silky striation. Fang as well as crown strongly curved. Cutting ridge descending as far on the posterior, as the anterior aspect of the crown. In a fractured New Jersey tooth, I count three dentinal cones. In one from Maryland, four. The inner cone is weakly fluted in both, but it scarcely affects the form of the enamel.

The typical tooth of this species, as compared with the T. antiqua, is more slender and curved. In a length of crown and fang slightly exceeding the largest of the latter, the diameters are all about one-half the same. Teeth from other portions of the jaw are but litle stouter.

	In.	*Lin.*
Length of tooth from New Jersey, (on curve,)	3	8.
Diameter at base crown,		6.6

Length of Maryland specimen 16.5 lines. Base of crown, 9 lines.

Miocene of New Jersey and Maryland.

THECACHAMPSA SQUANKENSIS, *Marsh.*

Sillim. Amer. Journ. Sci. Arts, 1869, p. 391.

The enamel of the crowns of the teeth, is in this species quite rugose. The cutting edges are short, and prominent; the general form cylindric and but little curved.

Miocene of Squankum, Monmouth Co., N. J. Mus. O. C. Marsh.

THECACHAMPSA FASTIGIATA, *Leidy.*

Crocodilus fastigiatus, Leidy. Proc. A. N. S., Phil., 1851, 327.

From Eocene of Eastern Virginia.

BOTTOSAURUS, *Agassiz.*

The characters of this genus have never been pointed out to the knowledge of the writer. In the general form of the under jaw and teeth it does not seem to differ from Alligator. One character which separates it from that genus appears to be similar to that which distinguishes Thoracosaurus from Gavialis, *i. e.*, the absence of long simple hypapophyses on the cervical vertebræ, and their substitution by low transverse or divided elevations. It also appears that the great external foramen which separates the angular, dentary and articular bones was closed up.

BOTTOSAURUS HARLANI, *Meyer.*

Crocodilus harlani, Meyer Palaeologica, 1832, 108. *Crocodilus macrorhynchus,* Harlan. Jour. Ac. N. Sci., Phil., 1824, 15 (name pre-occupied). *Bottosaurus harlani,* Agassiz. Leidy, Cretaceous Rept. N. Am., 12–14, Tab.

The teeth of this species are similar to those of Alligator in the short obtuse crowns. The pulp cavity is remarkably large and extends into the crown, leaving the dentine and enamel at the apex little thicker than the sides.

Besides the remains described by Leidy, portions of a smaller, perhaps younger, individual have been presented to the Academy of Natural Sciences by Dr. Ashhurst, from near Birmingham, N. J. They consist of various fragments of cranium with dermal plates. A tooth is compressed, but has a short conic acute crown, such as has not before been seen in this species.

The interorbital region is strongly pitted medially, and exhibits on each side a deep, short groove. There are no marked crests.

The dermal plates are about the size of Holops obscurus, but have smaller pits, wider intervals, and one margin without pits, but smooth and thinned out.

	Lines.
Width ramus where tooth series turns from inner to outer margin,	14.5
" interorbital space,	14.
" articular facet of mandible,	19.
Length dermal bone,	25.

It is difficult to refer vertebræ to this species with certainty, as they resemble so closely those of Holops. The species is less abundant than those of the latter, and being found with them the vertebræ, are easily confused. It is not impossible, for instance, that those referred to H. tenebrosus belong to this animal, as teeth of the latter were found near the same time and place. There have, however, come under my observation some vertebræ different from those of any of the Holopes, which correspond in size and rarity with the present crocodile. A description is therefore appended.

First—These are a fourth cervical vertebra, and some long bones, which were presented together to the Burlington County, N. J., Lyceum, and were procured at Gaskill's excavations near Birmingham in the same county.

The vertebra differs much in form from other species here described, and though absolutely larger than those of T. neocaesariensis, the neural arch was not coössified with the body, indicating the immaturity of the individual.

The body is but slightly concave between the planes of the parapophyses, which are not at all directed downwards; the latter are very short, and their articular faces are directed posteriorly and outwards anteriorly, the posterior portions being connected by a high crescentoid ridge, whose anterior margin approaches within three lines of the rim of the articular cup; behind, a weak median keel connects it with the body plane, which is succeeded by a prominent tuberosity close to the posterior shoulder. The anterior parapophysial articular surface extends without constriction to the rim of the cup. The floor of the posterior half of the neural canal is broken away, revealing a wedge-shaped chamber, which extends posteriorly and outwardly nearly to the shoulder.

	In.	*Lin.*
Total length,	2	10.
Length to shoulder,	2	3.
Width of cup,	1	8.
Vertical diameter of cup,	1	6.75
" " to edge of parapophysis,	2	
Width between parapophyses near cup,	1	10.
" " " at posterior angle,	2	1.
Length from post. angle parap. to shoulder,	1	1.25
Length from post. angle parap. to cup,	1	2.5

The radii of the median area of articulation are numerous, (34), fine and equal; the transverse rugae of the anterior area are also fine, thirteen in number.

Portions of femur, tibia, humerus, and ribs were in the same lot with the above described vertebra; they resemble the cervical vertebra in color and in the bright green of the matrix which adheres to them externally, as though they had been wet; their size relates so as to render their appertainance to the same animal probable. They indicate an animal of large size.

The shank of the femur is cylindrical at its middle; the prominence of the anterior flexure is situated well below the head, while the head itself is not as broad as in some species (*e. g.* Crocodilus Liporcatus). An obtuse ridge runs from behind forwards and downwards across the outside face of the shaft, transferring the position of the steepest face from the back to the front aspect. On the inner face the trochanter is small, and the surface is swollen near the upper edge at the flexure.

Compared with the shank of the femur of Hyposaurus rodgersi, the present is less depressed and lacks a longitudinal concavity, with obtuse elevated margins, near the superior flexure, which is characteristic of that species. For a considerable proximal portion of the femur, the medullary cavity is quite small; at the middle it is much larger, and the walls quite thin: measurements are,

	In.	Lin.
Length of portion of femur,	11	
Largest diameter below head,	2	11.25
Convex extent of head,	4	6.
Circumference of shaft,	4	9.
Diameter of tibia two inches below head,	1	10.
Length of condyles of humerus,	2	9.
Diameter of inner condyle,	1	10.
" region between condyles,	1	6.
" shaft 2.5 inches above condyles,	1	4.
Greatest diameter of head of rib,	2	

Second—A fifth cervical, two lumbars and fragments of long bones from Birmingham, N. J. The cervical is considerably larger than the last, and has the arches coössified ; its total length is 34½ lines, and is appropriate to the adult condition of this animal. The lumbars indicate further the difference between this species and the Hol. obscurus. The cups and shoulder are more expanded latterly than in any species here enumerated, even near the sacrum, and the centrum more depressed, and with concave sides. A very obtuse rib extends along the inferior face.

	In.
Total length,	3.85
Length to shoulder,	2.3
Width of cup,	1.76
" shoulder,	1.76

Both of these specimens represent the *Crocodilus basitruncatus* of Owen, and should their reference to the Bottosaurus by Leidy prove erroneous, will indicate a species under that specific name.

From the Cretaceous greensand of New Jersey.

HOLOPS, *Cope.*

This genus, which appears to differ from Thoracosaurus only in the absence of lachrymal fossae, has probably been represented by several species during the Cretaceous period in New Jersey. Vertebræ of two species have been described by Leidy as pertaining to the genus Crocodilus. All of them differ from the species of the existing six genera of Crocodilidæ in the absence of elongate hypapophyses on the cervical vertebræ, and their replacement by bified or simple often transverse tuberosities. As observed by Leidy, the T. macrorhynchus from the cretaceous of France presents a similar character.

The student should also notice that in this genus the axis is the longest vertebra, and the third cervical the most constricted. The third cervical vertebra, as well as the axis, is also in Alligator mississippiensis and Crocodilus biporcatus slightly more constricted than the succeeding vertebra. The cups widen above to the fourth dorsal; from this point to the sixth the centra narrow rapidly, presenting more difference than in the same distance elsewhere. The eighth begins to widen again, though still narrowed.

The lumbars grow widest as respect the centrum, to the sacrum. The two sacral vertebræ are the broadest and most depressed and their cups and balls are flattened.

The parapophyses rise from the atlas till they stand truncated above by neurapophysial suture on the fifth dorsal. On the sixth dorsal they stand just above the suture, and on the seventh on a level with anterior zygapophysis (H. brevispinis). Among modern Crocodiles, Caimans and Gavials, Cuvier found hypapophyses on the anterior five or six dorsal vertebræ; on the Holopes and Thoracosaurus these processes are visible on the eighth, and probably on the ninth in H. brevispinis Cope.

The teeth in this genus are much curved. They have long conic crowns with minute lateral cutting edges and minute striæ of the enamel, but no proper ridges as in Hyposaurus. The teeth in T. neocaesariensis are blunter than in the others. In the H. glyptodon, the teeth are coarsely fluted, and the surface everywhere, finely and sharply striate.

As the vertebræ of the species of this genus are very numerous, and the crania are usually much mutilated before coming to the hands of students, I give a synopsis of their characters, including those of Thoracosaurus and Bottosaurus.

I. Cervicals with deeply bifid hypapophyses, and transversely oval cup.

Dorsals with transverse oval cups.

T. NEOCAESARIENSIS.

II. Cervicals with short united transverse hypophyses, slightly bifid posteriorly; anterior extremities more or less quadrate.

Smallest species, vertebræ 16 lines long (without ball); cups of all transverse oval.

H. BREVISPINIS.

Large; dorsals about third and fifth, with subcordate outline and thin margins; *i. e.*, widened above, narrowed below, wider than deep; centra 20-25 lines; cervicals with subquadrate cup.

H. CORDATUS.

Large, centra 20-25 lines long; dorsals about seventh, etc., much compressed; cups deeper than wide, third and fourth regularly round or oval, not cordate, with thick lips; cups of cervicals round or transverse oval.

H. OBSCURUS.

III. Posterior cervicals with hypapophyses scarcely traceable, and well separated.

Large species; dorsals near seventh, with transverse oval cup, with thick margins; cups of cervicals subquadrate, bodies little keeled below; centra 20-25 lines long.

H. TENEBROSUS.

IV. Cervicals with a thick obtuse transverse ridge connecting parapophyses in place of hypapophyses.

Large; cup quadrate. BOTTOSAURUS HARLANI.

HOLOPS BREVISPINIS, *Cope*.

Thoracosaurus brevispinis Cope. Proceed. Acad. Nat. Sci., Phila., 1867, p. 39. Geological Survey N. Jersey, Appendix C.

The specimens on which this species are established are, a cervical vertebra in the Museum of the Academy of Natural Sciences, procured by Timothy A. Conrad at St. George's, Delaware, and one cervical, six dorsal, four lumbar, one sacral and four caudal vertebræ from the Greensand of Burlington County, N. J., which have been liberally placed at my disposal by the Burlington County Lyceum of Natural and Civil History. The last series is from the same individual apparently, and is more complete than that of any other cretaceous Crocodile hitherto brought to light. Also on a seventh dorsal, two lumbars and a humerus from the marl excavations of Samuel Engle, near Medford, Burlington County, New Jersey.

The last are from an adult, while the more perfectly preserved is not fully grown, since the neural arches of many of the dorsal vertebræ have separated at their sutures, yet its approach to maturity is indicated by the persistence of this arch of the third cervical, of some dorsals, lumbars and caudals. The species is the smallest of the genus, and will furnish reliable date for the estimation of the dimensions of other extinct crocodilia. The vertebræ are relatively more slender than those of the Alligators, and the general proportions are more probably those of the T. neocaesariensis and of the Gavials. This will give a basis of estimation for the head and tail.

	Inches.
Length of cervical series,	7.75
" dorsal "	15.
" lumbar "	6.25
" sacral "	2.33
Total body,	31.33
Caudal series (part estimated),	35.
Head (estimated),	13.
Total,	6 ft. $7\frac{1}{3}$ inches.

Cervical vertebræ.—Characteristic of the two of these before us, is the deep concavity of the inferior aspect of the centrum with only a trace of a keel, and the steep elevation of the same surface to the rim of the articular cup. The latter does not form a well defined ridge, but rather a plane, connecting the anterior extremities of the parapophyses, which, in the sixth, supports two short accuminate hypapophyses. In both cervicals the parapophyses look outwards at right angles to the centrum, but as in existing species, possess shorter articular surfaces on the third, whose body is also rather more elongate behind them. In the sixth, which will be typical of the posterior four of the series, from the crest of the posterior shoulder to the posterior outline of the parapophysis, is one-half the distance from the latter point to the margin of the anterior cup, and somewhat less than the articular face of the parapophysis. The posterior shoulder is elevated in both, and the articular globe is contracted and projecting.

The vertical diameter of the neural canal of the third is four-fifths the same as the anterior cup. The latter is small, its vertical diameter being only double the depth of the osseous elevation between the parapophyses. The neural spine is little elevated, compressed, its anterior margin subacute, and obliquely turned backwards to a posterior apex.

Measurements.	*In.*	*Lin.*
Third cervical, total length,	1	5.
Crest of shoulder to outer angle parapophysis,		6.5
Last point to plane of cup rim,		6.5
From middle ball to apex neural spine,	1	7.
Least width of base of centrum,		6.25
Sixth cervical (larger individual), length,	1	7.5
Vertical diameter between rims of cup,		10.5

The expanded bases of the neurapophyses leave only the cariniform epapophysis between them.

Dorsal vertebræ.—The first, third and fourth with the parapophysis on the centrum have lost only their neural arches. The parapophyses have convex articular surfaces, which have a very posterior direction and are followed by a deep depression in the side of the centrum; in the first they are a little behind the middle of the side of the body. The hypapophyses of all are distinguished by their lack of compression and their obtuseness. They are directed vertically downwards, the anterior face posteriorly. That of the first is bifid as broad as long, the others simple, longer than broad on the third. They are preceded by a depression behind the rim of the cup, and succeeded by a second, simple, small hypapophysis near the shoulder, which is finely many-grooved; it exists as a trace on the third, which of all the dorsals, may alone be said to present a very obtuse carina below. The surface in the first three is striate next the rim of the cup; on the shoulder on the first two. The sixth dorsal is more compressed and smoother: its cup is more produced upwards and outwards, while that of the first is more nearly round, and the others are intermediate.

The articular cups of dorsals near the seventh and eighth are nearly round, slightly deeper than broad. The horizontal width of the diapophyses is considerable, and the transverse extent of the articular (inferior) surface of the posterior zygapophysis is equal one-half the length of the centrum between shoulder and cup.

The seventh dorsal of the adult is perhaps twice as large as the above, without being half as large as the same in the H. obscurus. Though the centrum is as much compressed as that of the sixth, the cup is still broader than deep vertically. The centrum has a lateral longitudinal obtuse ridge. The hypapophysis is remarkably large for the position in the vertebral column. It is trigonal in profile with truncate planes before and behind, the anterior concave. The costal articular face is half way to the extremity of the diapophysis on its anterior margin. It is transverse, not vertical as in the sixth in H. tenebrosus.

Sacral.—The first exhibits a longitudinal concavity on the posterior half of the centrum below.

Caudals.—The body of an anterior caudal is not compressed, those of three others, but slightly so; the cup of the first is round; those of the others deeper than broad. Three have stout diapophyses; of these the two posterior have a concave inferior face separated by a strong angle from the sides, while there is an additional lateral angulation on the anterior part of the side of the more anterior. In the two anterior, the neural spine is twice constricted from base probably to near apex, leaving an anterior laminiform portion, and a median much stouter. In the caudals the suture of the neural arch is much obliterated.

Measurements of Vertebræ.

Of Adult.	*In.*	*Lin.*
Seventh dorsal; total length,	1	8.
depth articular cup,		10.5
width,		12.
longitudinal width neural arch (greatest),	1	8.
" " diapophysis,		11.

Of Young.	*In.*	*Lin.*
Sixth dorsal; total length,	1	5.
length to shoulder,	1	1.5
depth neural canal to end hypapophysis,	1	1.5
" articular cup,		9.25
width " "		11.

Measurements of Vertebræ.

Of Young.	*In.*	*Lin.*
Eighth? dorsal; total length,	1	5.
length to shoulder,	1	1.
longitudinal line between zygapophyses,	1	5.5
horizontal base of neural spine,		11.
depth of neural canal,		4.5
" " articular cup,		9.5
width of " "		9.5
neural suture to nearest diapophysis,		3.
Third? lumbar; total length,	1	5.
length to shoulder,	1	1.
longitud. line between zygapophyses,	1	6.
horizontal base of neural spine,	1	
depth neural canal,		4.75
" articular cup,		9.
width " "		11.
First sacral; length,	1	2.75
anterior width centrum,	1	.75
posterior " "		10.
depth neural canal,		4.75
" articulation of diapophysis,		11.
length " "		9.
width neural arch between diapophyses,	1	2.5
Anterior caudal; length,	1	5.
" to shoulder,	1	1.5
depth neural canal,		4.5
" articular cup,		8.
width " "		8.75
width inferior plane,		4.
Distal caudal; length,	1	5.5
" to shoulder,	1	3.25
depth cup,*		6.
width "		5.
length base diapophysis,		3.75

None of the vertebræ exhibit a constriction of the neural canal by a ridge on each of its sides, as is seen in the H. tenebrosus.

This specimen is named from the short longitudinal and vertical extent of its hypapophyses.

A right *humerus* accompanying three vertebræ of the adult, has the same color and mineralization, and was found with them; it probably belongs to the same animal. Compared with a humerus of H. obscurus of medium size, it is three-fifths the length and has more strongly marked articular faces. The head is more transverse, less rounded, and more strongly divided into the scapular and coracoid faces. The width of the head is one-fourth the length, and reaches the summit of the deltoid crest. This crest is lower down in H. obscurus, the above width only reaching its proximal base. The anterior face above the crest is concave in H. brevispinis, nearly flat in H. obscurus. There is a moderate internal tuberosity distally, and the condyles are moderately prominent. Coronoid fossa well marked.

*Measurements of the articular cup are always made from middle to middle of the rim.

	In.	Lin.
Length,	6	8.
" to middle of deltoid crest,	1	8.5
Width of head,	1	7.
" shank at middle,		8.5
" condyles,		17.5

A mass of induarted marl, with vivianite and oxide of iron from Monmouth County, N. J., submitted to me by Prof. G. H. Cook, contains the posterior part of the cranium of this species, with cervical, dorsal, lumbar and caudal vertebræ, dermal plates and coracoids. The individual was immature, as shown by the non-anchylosis of the centrum of the atlas, the neural arches, etc.

The cervical has the small hypapophysis composed of two small separated tubercles slightly prominent. The dorsal, with a prominent hypapophysis which is trincate in front and at the end, has the round cup characteristic of this species and the H. tenebrosus. The dermal plates are large, elongate-quadrate, considerably exceeding the frontal region in width. Their fossae are in some deep, wider than the interspaces, in others smaller, the plate with a broad smooth bevelled border.

The cranium exhibits the specific and generic characters very well. The muzzle is broken off at the anterior extremity of the pre-frontal bone, showing that there is no foramen as in Thoracosaurus. The acute posterior extremities of the nasals remain. At the anterior border of the orbits the lachrymal is wider than the pre-frontal, and the pre-frontal wider than the frontal.

The pre-frontal suture does not extend further back than opposite the middle point of the diameter of the orbit, No part of the orbital margins are everted, except for a shorter distance on the malar bone. The temporal or crotaphite fossae are of about the same area as the orbits. The width separating them is very little less than one-half the distance between the orbits. The anterior wall of the foramen is not quite vertical as in H. tenebrosus, nor very oblique as in another species. The sculpture is less marked than in the latter, and though it would become perhaps more profound with age, it is quite different in pattern from these. There are small pits near the orbital margins, and shallow grooves which incline backwards towards the median line, which is almost smooth. There are no grooves or pits on the interparietal region. In H. obscurus there are large deep pits all over the frontal, which is concave, and broad smooth margins and a median line of pits on the parietal bone. In the the third species (figured by Leidy Cret. Rept., II., 8,) the pits are more numerous and the interparietal wider, and with marginal grooves. The anterior face of the crotaphite fossa is very oblique, or thickened inwards below, while it is vertical in the H. obscurus.

	Postfrontal suture, width.	*Frontal width.*	*Parietal width.*
H. brevispinis,	.52	1.23	.6
H. obscurus,	.8	2.	.55
H. ? sp.,	.7	1.95	.68

The surfaces of the malar, postfronto-parietal and post-temporal arches are marked with distant shallow pits. The superior concealed insertion surfaces of the supraoccipital are largely exposed, and rugose.

The basioccipital, sphenoid and pterygoids are more or less exposed. The first is vertical, with latero-inferior processes directed upwards. The sphenoid has a very narrow exposure, but this is horizontal. The posterior-inner processes of the pterygoid lie closely appressed to the sphenoid and basioccipital laterally. This arrangement is much as in the living Gavialis gangeticus. The posterior nares are more anterior, however, and the septum not completed. Their plane is perhaps a little above that of the orifice of the eustachian tubes. The lower extremity of the basioccipital, has a well-marked posterior keel.

Measurements.

	In.
Length (median above,) to apex prefrontal,	5.5
" (axial) to front of orbit,	4.15
" " " crotaphite foramen,	2.2
Width between extremities quadrata,	6.2
" " postfrontal angles,	2.
" muzzle at point frontal,	3.32
Length dermal scutum,	2.3
" cervical vertebra (to ball),	1.7
Width crotaphite foramen,	1.7

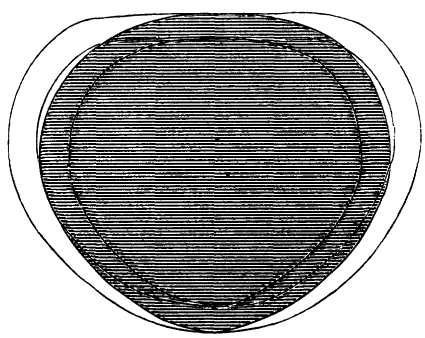
This species furnishes the generic characters. I have not been able to ascertain the non-existence of the prefrontal foramen in the following species, but as they bear more resemblance in the cranial sculpture and in size to this species, than to Thoracosaurus neocaesariensis, I refer them at present to Holops.

HOLOPS CORDATUS, *Cope.*

Of this species I have only two cervical, two dorsal, and three lumbar vertebræ of one individual, all in a good state of preservation. They present characters similar to those of H. obscurus in the cervical vertebræ, and intermediate between those of that species and the H. tenebrosus in the dorsals. While the fifth dorsal in the former is deeper than wide in its articular cup and slightly quadrate, the present species presents a broadly cordate cup to the fifth, narrowed below, yet considerably wider than deep; the H. tenebrosus presents a regularly round or transversely oval cup in the same position, much as in H. brevispinis. The accompanying cut exhibits the difference between this species and the H. tenebrosus. The cordate form is distinct on the fourth dorsal, where in H. obscurus the cup is regularly oval. The cervicals are not different from those of H. obscurus, except that the cup is rather more prolonged below, or subquadrate.

The cervical vertebræ referred to this species may be known by the outlines of the anterior extremity outside the cup, of which the latter partakes, which is between quadrate and cordate; by the distinct inferior concavity between the parapophyses, and by the gradual but complete lateral eversion of the latter. In the types the posterior shoulder is remarkably prominent. The inferior carina is little marked on the fourth, while the hypapophyses are small and united. In a fifth, judging from the more posterior position of the parapophysis, it is formed of two partly confluent subacute elevations.

Fig. 18.



The dorsal vertebræ, from their nimeralization, condition, and time and place of discovery, probably belong to the same animal as the cervicals above described. The breadth of the cup of the fifth is a little greater than the length to the posterior shoulder, it differs from Leidy's figure of the sixth of tenebrosus, T. III., f. 13, in its large hypapophysis, which stands on nearly the entire centrum, and is very prominent, and concave in front; the sides of the centrum are concave from cup to shoulder. In the third dorsal but a narrow space exists behind and before the hypapophysis, and the vertical diameter of the cup is less than the transverse, and exhibits the same cordate outline. As usual some (the anterior) lumbars are deeper than wide, and in others the bodies are subquadrate in section, and the transverse diameter of the cup greater. Measurements are as follows :

	In.	*Lin.*
Third cervical : length to shoulder,	2	0.75
" " " opposite posterior angle parapophysis,	1	4.5
" " width between latter points,	1	10.5
" " least width behind parapophyses,	1	2.
" vertical diameter cup,	1	5.25
" transverse diameter cup, above,	1	5.25
" " " " below,		11.
Fourth cervical : length to shoulder,	2	
" " " end parapophysis,	1	2.25
Third dorsal : length to shoulder,		23.
" " " opposite posterior angle parapophysis,		10.5
" " " of basis of hypapophysis,		14.25
" " width between ends of parapophyses,		33.75
" " " of neural arch just behind diapophyses,		26.
" " " of anterior cup,		22.5
" " " of neural arch,		5.25
" vertical diameter neural arch,		7.5
" " " cup,		19.
Fifth dorsal : length to shoulder,		21.
" " " basis hypapophysis,		14.
" " width of centrum at middle,		12.25
" " " cup,		21.25
" " vertical diameter at middle,		18.
Lumbar : length to shoulder,		25.5
" vertical diameter cup,		20.
" transverse,		19.

Portions of the frontal and parietal bones of a gavial are figured by Leidy (III., fig. 8). They are shown under the head of H. brevispinis not to be referable to the cranium of that species, or of H. tenebrosus ; whether they can be referred to H. obscurus, H. cordatus, or H. glyptodon is as yet uncertain.

This species is no doubt a gavial-like animal, very near the T. obscurus. It is sufficiently different in vertebral structure ; probably other differences will be found where other bones are known.

HOLOPS GLYPTODON, *Cope.*

Thoracosaurus glyptodon Cope. Geol. Survey of New Jersey, Appendix C.

This species is indicated by a few teeth only, but they are of so marked a character as to render their recognition and arrangement proper.

The best preserved specimen indicates a slender, subcylindrical strongly curved crown, with the acute ridge which divides the planes extending to its base. There are probably nine obtuse ridges on the inner or concave face, each about as wide as each interval. Both ridges and grooves are covered with sharp fine longitudinal striae, which are continually interrupted and irregular.

The pulp cavity, as on others of the genus, is rat her small. Length of crown, 12 lines ; diameter at base, 4.5 l. The apex is slightly compressed and smooth. In an older specimen the minute striæ are less distinct, leaving the fluting.

From Barnesboro, Gloucester Co., N. J. Not found with or near any of the preceding specimens, but with dermal plates not distinguishable from those of H. obscurus.

HOLOPS OBSCURUS, *Leidy*.

Thoracosaurus obscurus, Cope, Geol. Surv. N. J., App. C. *Crocodilus obscurus*, Leidy, Smithson. Contrib., 1865, p. 115. Tab. II, fig. 4. *Undetermined crocodile*; teeth tab. I, f. 7, 8, 9.

This species was established by Prof. Leidy on vertebræ from Barnesboro, Gloucester Co. and Arneytown, Burlington Co., New Jersey. I have procured numerous vertebræ from the former locality, which were associated with a cranium, which was nearly destroyed before reaching my hands. Enough, however, has been preserved to indicate with certainty that it is a gavial, and probably of the same genus as that to which Cook's Monmouth County skull belonged. Numerous dermal plates were procured at the same time, which however are not more certainly to be ascribed to the T. obscurus than to the T. tenebrosus, of which several portions were discovered in the same excavations.

The vertebræ from Barnesboro in my possession have apparently pertained to two individuals; two cervicals, a second and fifth dorsal, with six other dorsals and lumbars and a caudal, of the one, and a first and fifth dorsal with eleven other dorsals and lumbar vertebræ, of the other individual.

In addition to these, I have examined two cervicals found with muzzle and long bones at Barnesboro; a fine series of vertebræ and other bones in the Museum of the Academy from near Birmingham; three fine series in possession of Prof. G. H. Cook,† the Mount Holly Lyceum Natural History, and Prof. O. C. Marsh of Yale College, all from Birmingham; portions of two individuals in my own collection from the same place, and a set of eight vertebræ from Mullica Hill in my possession. Numerous other specimens of this species have fallen under my examination. Hence it is obvious that this is the most abundant gavial of the New Jersey Cretaceous.

A series of *cervicals* from Birmingham is instructive, showing the differences in the characters of the respective vertebræ, The axis, which as usual is coössified with part of the body of the atlas thereby much increasing its length, has parapophyses represented by two crests directed downwards and separated by a deep longitudinal cavity; they are united in front. An obtuse ridge on the side of the centrum separates two longitudinal concavities. The third cervical is also deeply concave below, since the parapophyses descend much below the plane of the centrum, and are united by an arched connection in front, which is not separated from the rim of the cup. As usual the parapophyses continue to rise, till on the sixth they are a little above the plane of the centrum. They also become more posterior, till on the sixth their centre is opposite the middle of the centrum without ball: on the seventh this point is behind the middle. The first dorsal is readily distinguished by the small size and posterior direction of the articular face of this parapophysis; its middle is a little below opposite the middle of the cup. On the third dorsal the same point is just above opposite the middle of the cup.

On the fourth cervical a trace of median inferior keel exists; it is quite strong, but thin and concave on the fifth, while on the sixth it is thicker, and does not separate deep concavities, but only slightly concave planes. It is still more elevated on the seventh, and increases beyond. On the third there is no distinct hypapophysis. On the fourth, a transverse elevation on the anterior arch connecting the parapophyses marks it; on the next it appears in the same place as two small longitudinal tubercles with groove between. On the sixth they are similar but stronger. On the seventh it is much more elevated, the groove between its halves being now a transverse plane. On the first dorsal it is a simple, large process, extending over half the centrum with a small knob behind it: on the third it has a longer base, but on the second the longest, extending the whole length of the centrum. On the fifth it is thick, with rounded edge below, and with a truncate triangular face in front. It is apparent on the eighth, as an obtuse elevation in front.

From the fourth posteriorly the characters are drawn from other series, which show many of these vertebræ.

The cups of the third to fifth cervicals look a little more truncate below, owing to the prominence of the transverse ridge. They are almost perfectly round thence to the second dorsal, where the transverse diameter begins to exceed the vertical a little. First on the fifth dorsal the cup assumes some of the narrowed form of the centrum.

The very numerous lumbars present nothing peculiar. As in other species they are more or less striate grooved at the bases of the cups and balls.

The series first mentioned as from Barnesboro presents typical characters of the cervical hypapophyses.

† The types of T. obscurus preserved in the museum of Rutgers College have been kindly placed in my hands by John Smock, Asst. State Geologist.

It is in the third a short acute transverse crest truncate in front, gradually inclined behind; fourth, a similar crest curved into a crescent quite as in Leidy's plate* above cited under T. obscurus. In the fifth they are two weak elevations, much less marked than in the above in my possession. All the above exhibit a well marked constriction between the parapophyses and the rim of the cup. The dorsals with hypapophyses are distinguished by the less cordate form of the articular cups, they being relatively broader below, and in the second to fifth, narrower above than in the T. cordatus. Their neural arches have on the inner faces a ridge constricting the neural canal slightly. The hypapophysis of the two-fifths in my possession are rather short, broad and obtuse.

The cervicals may also be known by their strong posterior shoulder, and constriction of the body behind the para pophyses, where the width enters the length (exclusive of ball) twice: the relation is 1:1.5 in T. neocaesariensis. The parapophyses are most abruptly turned out, and are directed downwards, thus embracing a median concavity which is divided by a rather narrow carina. Separated from the rim of the cup by a narrow transverse plane, a hypapophysial elevation extends transversely between positions in front of the parapophyses: this is less elevated medially than exteriorly, the latter position being marked by a prominent angle.

The articular cup of the first *dorsal* is a slightly transverse oval. The lumbar vertebræ exhibit little to distinguish them from those of other species. An anterior caudal is more depressed than that from near the same position in T. brevispinis. The cup is broader than high, and the inferior plane broad and concave.

Measurements.		*In.*	*Lin.*
Fifth cervical;	total length,	2	9.
	length to shoulder,	2	1.5
	width of neural canal,		9.
	" between ends diapophyses,	2	8.5
	" " " parapophyses,	1	9.5
	lateral depth of body in front,	1	9.
	median " " "	1	8.
	depth articular cup,	1	4.
	" " "	1	4.75
Seventh dorsal;	total length,	2	7.
	length to shoulder,	1	10.5
	width neural canal,		6.25
	depth anteriorly, with hypapophysis,	1	11.5
	width of cup,	1	6.75
	depth "	1	6·25
Posterior dorsal;	length to shoulder,		24.25
	vertical diameter cup,		20.75
	transverse " "		19.

The *mandible* preserved, indicates an animal of considerable size. Estimated according to the proportions of existing Gavials its length would have been :—

	In.
Head,	28.70
Body,	92.85
Tail,	69.64
Total,	Ft., 15 ; In., 11.19

	In.	*Lin.*
Length of mandible preserved,	13.	
" symphysis,	11.5	
" splenial in front of fork,	4.6	

* II, fig. 4.

	In.	*Lin.*
Width at anterior point of splenial,	2.	
" near extremity,	1.9	
" an inch behind fork,	1.	4
" between rami at same point,		13
Teeth opposite symphysis,	13.	

The larger teeth are all broken, but one with fang exposed, would probably measure when complete 1 in., 10 lin. The form of some of the smaller is well represented in Leidy's figures above cited; they are acuminate, strongly incurved, of a full lenticular section, with an anterior and posterior raised cutting ridge, in the transverse plane of the crown. The sides present numerous narrow weakly defined facets, and are in a half protruded one, finely striate. The alveoli do not open on the horizontal plane of the inside of the mandible, but the latter is raised above them for the posterior half of the symphyseal portion of the jaw; the latter is more depressed towards the extremity. Teeth from other specimens and localities exhibit marked characters. They are all much curved and slender conic, and subcylindric; the tip smooth, the remainder more or less extensively minutely striate, but not fluted or ridged. The fang is slightly flattened. In T. neocaesariensis the crowns are relatively shorter, less curved and more obtuse; in both the anteroposterior dividing ridge is well marked. Part of the teeth attributed by Leidy to Hyposaurus belong here; see synonymes.

The *muzzle* of a larger individual from Birmingham, accompanied vertebræ of this species, with a smaller gavial cranium in fragments; and a cervical vertebra similar to that described under Bottosaurus harlani. Its reference to this species is not certain, but I give a figure of it.

The lateral maxillo-premaxillary suture is not preserved, so the number of premaxillary teeth cannot be exactly ascertained; there are four to the line of the posterior margin of the large incisive foramen, of which the anterior is quite small. The posterior palatal suture of the same element is prolonged in a narrow chevron on the median line below, to opposite the eighth alveolus from the front; there are nine alveoli behind this point, to the broken extremity. A noteworthy character consists in the presence at the posterior part of the series of deep fossae between the maxillary alveolæ for the reception of the mandibular teeth, showing that the latter did not project externally between the former, as in the existing gavial. The same structure appears in the smaller cranium which accompanied it,* but is not found in the Thor. neocaesariensis.

Fig. 19.

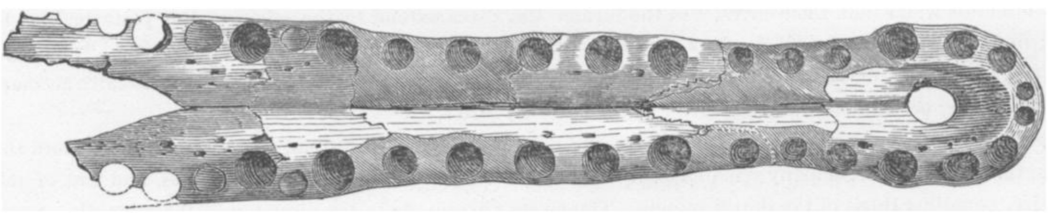
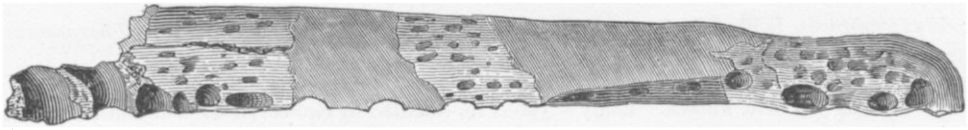


Fig. 20.



* The fronto-parietal region of this one is described under head of H. brevispinis.

Measurements.	*In.*	*Lin.*
Length of muzzle to 16th tooth,	16	0.5
" " " extremity of premaxillary bone,	7	1.
" " " to posterior edge incisive foramen,	2	4.5
" " " to anterior " " "	1	7.5

Humerus.—This, with a femur, belongs to the right side of the series from Birmingham, first described. Its characters are indicated under the head of T. brevispinis. The shaft is rather slender and curved outwards; the head is strongly curved backwards; its articular face is narrow, and remarkably convex. The condyles are broken away, leaving the comencement of the coronoid fossa:

	In.	*Lin.*
Length (restored),	9	5
" to summit deltoid ridge,	2	11
Width head,	2	3
Circumference shaft (least),	2	1

Femur.—This piece is perfect; two distal ends from Barnesboro, besides numerous proximal ends, have also come into my hands. It is more slender than in the caimans and crocodiles of the present day. The inner trochanter is quite prominent, the articular face of the head very convex. The shaft is sigmoidally bent anteroposterioly, and is bowed extero-internally, with a subordinate abrupt incurvature below the head. The latter is largely caused by a prominent thickening on the inner side. The outer condyle is twice the size of the inner, and they are continued into obtuse crests on the upper face of the bone, of which the outer is much more elevated. Below their sides spread apart.

	In.	*Lin.*
Length,	10	7
" of head (straight),	2	7
" (transverse) of condyles,	2	3
Least circumference of shaft,	3	5

Of *dermal bones*, those of two species, perhaps of more, were procured from the excavations that produced four species of Gavials, with Bottosaurus,* and to which they are to be referred is not very clear. In the one, the pits or fovea are very large and are separated by narrow elevated partitions; in the other they are small and are separated by flat intervals wider than themselves. In the former the fovea extend to the edges of the plate on the bevelled edges; in the latter, the bevelled edges are without fovae. Leidy says of those of this type, "plates coarsely foveated." The first described belong to the median series of the present species, as they usually accompany its bones when they occur alone; and the latter to the external series.

Parallelogrammic dermal bones without pits, and with very high longitudinal crests, standing on more than half the length, frequently accompany remains of this species. They are cervical or nuchal bones, and are of relatively large size, equalling those of the dorsal region. The crests are oblique in the direction of their length. Such bones belong to this species, perhaps to H. cordatus also.

HOLOPS TENEBROSUS, *Leidy.*

Crocodilus tenebrosus, Leidy. Cretaceous Reptiles U. S., 115. Tab. III., figs. 12–15. *Thoracosaurus tenebrosus* Cope. Geological Survey of New Jersey, Appendix C.

This species is as yet little known. Leidy's type is represented by two cervicals, a seventh dorsal, a caudal, and portions of humeri; on account of their close resemblance, and marked specific separation from H. obscurus, I regard as the same an animal of which a cervical and three lumbars are preserved in my collection. The dorsals exhibit a

*Several simple coprolites which accompanied these remains, probably belonged to the same species.

round cup with thick edges. In the cervicals the hypapophyses are represented by rudimental elevations separated by a space, except on the third, where there is the usual anterior cross ridge, followed by a concavity. I refer here a dorsal, kindly lent me by Prof. Marsh, where the cup is more transverse oval than in T. obscurus.

The lumbars from Barnesboro are characterized by a form more slender than those of the T. tenebrosus, more nearly resembling some from the series of T. obscurus. Measurements of:

	In.
Fifth cervical: length to shoulder,	21.
" posterior angle parapophysis,	15.
" anterior " "	6.
width to posterior angle parapophyses,	19.25
" behind the parapophyses,	13.25
" of cup above,	15.
" vertical diameter cup,	15.25
" neural canal,	8.
Lumbar: length to shoulder,	24.
vertical diameter cup,	18.
width of " "	17.
" neural canal,	5.
" basis of neural arch in front,	15.

Specimens of an adult from the pits of the West Jersey Marl Co., near Barnesboro, Gloucester County.

THORACOSAURUS, *Leidy.*

Cretaceous Reptiles, Smithson. Contrib., XIV., 5. Pr. Ac. N. Sci., Phila., 1852, 35.

This genus adds to the characters of Holops, a pair of large prefrontal foramina similar to those characteristic of Teleosaurus, and Plesiosaurus. The other cranial characters, as well as the vertebral, are very different from those of Teleosaurus, which is amphicoelian, and are rather those of the existing Gavialis. The teeth and cervical vertebræ, however, differ from those of the latter genus.

What is not seen in Gavialis or Holops is the character here presented, of a strong septum dividing the posterior nares most completely; the latter open inferiorly and opposite the hinder part of the crotaphite foramina.

A species, the T. macrorhynchus, occurs in the cretaceous of France, as observed by Leidy.

THORACOSAURUS NEOCAESARIENSIS, *Dekay.*

Leidy. Smithsonian Contributions, XIV., 1865, 5. Tab. I.

Gavial Dekay Ann. Lyc. N. York, 1833, 156. Tab. III., fig. 7–10. *Gavialis neocaesariensis* Dekay. Zool. New York, 1842, pt. III., 1844, 82. *Crocodilus s. Gavialis clavirostis* Morton. Proceed. Acad. Nat. Sci., Phila., 1844, 82. Giebel Fauna v. Vorvelt, 1847, 122. *Crocodilus basifissus* Owen. Journ. Geol. Soc., London, 1849, 381, Tab. X., f. 1, 2. Palaeontology, 1860, 277. Pictet Traité de Palaeontolgie I., 1853, 482. *Crocodilus dekayi* Leidy. Journ. Acad. Nat. Sci., II., 135. *Sphenosaurus* Agassiz. Proceed. Ac. N. Sci., Phila., 1849, 160. *Thoracosaurus grandis* Leidy. Proc. A. N. Sci., Phila., 1852, 35.

Cretaceous limestone of Vincentown, Blackwoodtown, and Big Timber Creek; sandstone of Navesink; greensand of Blackwoodtown, Barnesboro, and Monmouth County, New Jersey.

Several individuals of this, the largest of our cretaceous species, have been found, but only fragments preserved. The cranial bones are smoother than those of the species of Holops, and the posterior nares are separated as above mentioned. The cervical vertebræ of this species are distinguished among those of its congeners by the lack of inferior concavity, breadth of basal carina, complete bifurcation of low hypapophyses, and posterior and transverse position of parapophyses.

AMPHICOELIA.

HYPOSAURUS, *Owen.*

Journ. Geol. Soc., London, V., 383.

This genus is as yet the only known representative on this continent of the Amphicoelian Crocodiles. It belongs, says Owen, to the Teleosauridae, from which the great size of the parapophysis distinguishes it. Its remains are quite abundant in the New Jersey cretaceous; stratigraphically its position is the latest of its family. Thoracosaurus being the earliest of the Procoelian Crocodilia, the interesting spectacle is presented of the coexistence in America in large numbers, of two types which, in the old world, are separated by the whole period between the Jurassic and Tertiary.

As might be supposed then, there is some approximation in structure between these two extreme genera of their series. The hypapophyses of the cervical vertebra in Thoracosaurus are of the Teleosauroid type. Both are alike slender-nosed genera, as I have been able to ascertain for the first time for some of them.

As a Teleosaurian reptile the bassioccipital does not present the vertical position usual among the Procoeli, but is horizontal. The sphenoid is also more horizontal in its exposure, and much wider, and with a straight anterior margin, not incised to accommodate the posterior nares. The frontal bone is marked with longitudinal shallow grooves.

The teeth of Hyposaurus are more compressed than in the last genus described, some of them are from the shortening of the crown almost triangular in outline, but most are elongate; the enamel is thrown into a few fine continuous ridges.

The cervicals may be distinguished from those of the other gavials of New Jersey, in addition to the form of the articular faces, by the earlier appearance of a strong keel-like hypapophysis, that is, on the fourth of the series; at first it is most prominent at the anterior end.

HYPOSAURUS ROGERSII, *Owen.*

Loc. Cit. Leidy, Cretaceous Reptile N. Am., p. 18, Tab. III, 4–21.

Vertebræ.—The neural spines of the cervical vertebræ are acuminate, of considerable—finally, of great—height, the anterior standing transversely on the neural arch, the median subtetragonal, the posterior, as usual, longitudinal in section. In an anterior cervical vertebra, length 2 in., the spine is 2 in. 10 l. above the ceiling of the arch, and is acute ; it receives a strong lateral wing from each posterior zygapophysis, which does not disappear till near the tip. These enclose a deep groove on each side behind, with a strictly perpendicular posterior median

rounded rib ; in front a narrow keel extends from the tip to the neural canal ; the lateral alæ are curved backwards. On a more posterior cervical, the lateral alæ are very heavy, short and rounded, and enclose no groove with the slightly projecting posterior vertical rib, while the anterior keel has become a strong compressed wing, dividing two shallow anterior grooves ; breadth and length equal in section. In a last cervical, length 2 in. 12 l., the longitudinal section (equal about an inch) is longitudinal cuneiform, owing to the projection of the anterior ala. In an anterior dorsal the section is longitudinal (1 in. 5 l.); the lateral ribs remain at the base only, and the posterior carina is strong and sharp ; it is acuminate, and was probably subacute, but is broken at tip ; if restored would measure 4 in. 6 l. at least.

Humerus.—This element is relatively much shorter than in Thoracosaurus or modern Crocodilia ; it is also stouter and more curved than these, and furnished with very largely developed deltoid crest and condyles. One specimen accompanying femur from the same—the right side, and many other elements from near Birmingham, Burlington County, N. J., have been submitted to me by Prof. Cook.

The condyles are deeply divided, and project far before the coronoid fossa, which is little marked. The shaft is nearly cylindric, strongly arched backwards. The groove bounded by the deltoid crest is very deep. A portion between the head and the crest is lost. The former is truncate above, with a very oblique coracoid face. The medullary cavity is very small.

	In.	*Lin.*
Total length (restored),	10	
Length from condyles to deltoid crest,	6	7.
" across head (straight),	3	2.
" across condyles,	3	0.5
Least circumference of shaft,	4	2.

Femur.—The shaft of the femur is a most characteristic piece from the greensand of the Eastern States. It is rather more than usually flattened intero-externally, and at the point of insertion of the adductor muscle is trilateral in section from the elevation of the ridge of insertion, and the depression of the antro-inferior face into a shallow, longitudinal concavity. The ridge and the surface behind it are rugose. The shaft below and up to the head is longitudinally concave on the inner side, plane on the outer. The articular face of the head has a remarkable antero-posterior extent, and is more obliquely produced upwards and forwards, in relation to the longitudinal axis of the shaft than in the other species. To support it the end of the shaft is turned forwards and strengthened by thickness, having a flat anterior face not seen in other species, and the articular face is bent downwards at right angles to it, and to the course of the longer posterior portion. It is here widest also. This form gives an unusual anteroposterior range of motion, and is appropriate to a powerful swimmer. The insertions for powerful muscles would indicate the same.

The condyles of this femur are lost.

The *teeth* have some resemblance to the Polyptychodons in their strong ridges, but they have distinct anterior and posterior cutting edges, dividing a larger external from a smaller internal surface, the anterior turning in towards the latter, near the base of the crown. The section of the base of the crown is a broad oval, tip more compressed and worn obliquely outwards by use. Internally eight, externally eleven strong, but fine ridges extending over the usual half or two-thirds, alternating with shorter ones ; all obsolete at base anteriorly. The color of the two teeth is black at base, ochre at tip ; between, lined by both colors.

	Lines.
Total length tooth,	22.5
" crown,	9.
Diameter antero-posterior at base,	4.

These teeth are in the alveolae of a distal portion of the maxillary bone, 4 in. long. Three in. one line includes three alveolae, measuring between margins. The muzzle has been here very slender, as the measurements show, made at the posterior tooth ; the anterior teeth issue successively higher up, and above the palatine plane.

	Lines.
Width of palate,	18.5
Height of os maxillare at middle,	14.
Thickness of palatine suture of o. maxillare,	2.5

Cretaceous Green Sand of New Jersey.

HYPOSAURUS FRATERCULUS, *Cope.*

Spec. nov.

This small species seems to be clearly indicated by a portion of the ramus mandibuli containing three and half a fourth alveoli, and two perfect teeth. These parts are less than half the size of those of the smaller individual of H. rogersi, whose maxillary bone and teeth are described in the preceding article. The crowns of the teeth are shorter and more compressed than those in the corresponding part of the jaws in H. rogersi; they are marked with a coarse obtuse fluting to near the tip, with a finely striate enamel as in Holops glyptodon; in those of H. rogersi, the enamel is smooth and ridged by fine keels, which do not extend more than half the length of the crown.

That the animal of which I describe this fragment was not the young of the larger Hyposaurus, is, I think, indicated by the deep grooving and strong ridging of the dense layer of bone of the ramus; by the minute pulp cavity of the crowns of the teeth, and by the well developed successional tooth in the fang of one of the latter, whose apex has nearly reached the alveolar margin. That the individual is not fully grown is probable, but that it is of smaller species than the H. rogersi, there appears to be little room for doubt.

The ramus is scarcely flattened below, as is the case with most gavials, and the depth at the symphysis is equal the width of each ramus. Sculpture in deep longitudinal grooves slightly inosculating. Teeth directed very little outwards: their fangs and crowns are considerably compressed; the antero-posterior cutting edge is stronger than the ridges, and does not diminish to the base of the crown. Viewed from within the form is symmetrical and straight; from behind their crown is greatly incurved. The outline of the crown from within is an isosceles triangle, the width, more than .66 the height. Ribs on the inner face, seven, on the outer, eight. A few teeth in the jaws of H. rogersi are as short and broad as those here described, but they are not found in the middle of the series as in this species, but probably belong in the posterior alveoli, as occurs in some alligators.

	Lines.
Length of fragment,	19.3
Width at middle,	6.
No. of alveolae in an inch: three and half and interspace.	
Length tooth above alveolus,	4.
" crown of tooth,	2.75
Width " " at base,	1.75

From the middle Green sand bed at Birmingham, Burlington, Co., N. J. Presented to the Academy by Judson C. Gaskill.

INCERTAE SEDIS.

The following species probably belongs to the Amphicoeli, but to what genus cannot well be determined, as nothing but the teeth are known.

CROCODILUS HUMILIS, *Leidy.*

Trans. Amer., Phil., 1860, p. 146. Tab.
Bad Lands of the Judith River, Nebraska.

APPENDIX TO THE CROCODILIA.

PEROSUCHUS, *Cope*.

Proc. Acad. N. Sci., Phila., 1868, p. 203.

Characters.—Toes 5—4, with claws two-three. No osseous nasal septum or bony eyelid. Belly protected by series of osseous plates, as well as the back.

All the genera of Crocodiles hitherto known as living, are characterized by the possession of three claws on the fore-foot. The present therefore offers a remarkable exception. The free fingers and half webbed toes, and the bony abdominal buckler, together with the cartilaginous nasal septum, are points of strong resemblance to Jacare (Gray including *Caeman* Gray) but it differs from these creatures in the lack of bony orbit. In specific characters it differs from those of this genus which it most resembles,—as J. *nigra*, in the absence of a transverse bony ridge between the orbits. Another feature of importance is the relation of the canine teeth of the lower jaw to the upper. On one side this tooth is received into a notch as in Crocodiles, on the others, it enters a pit of the maxillary bone, within the border of the same as in Alligators! This remarkable combination may be abnormal even in this species, but this cannot be now ascertained, as it rests at the present time on a single specimen only. As its affinities are rather more Alligatorial, I am disposed to anticipate that the dental arrangement of the latter animals will be most common.

Fig. 21.

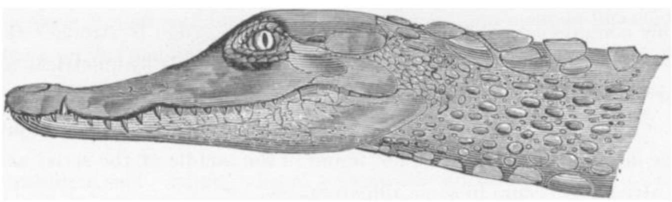


Fig. 23.

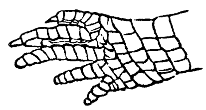


Fig. 22.

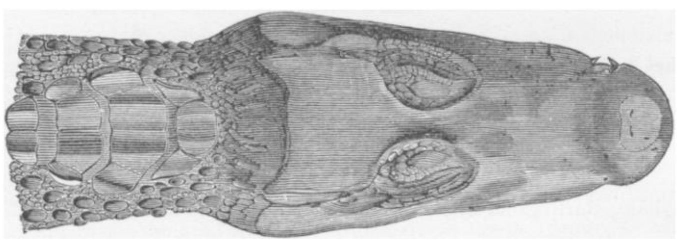
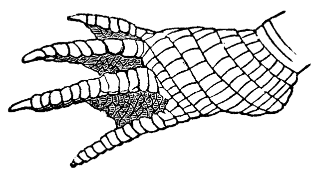


Fig. 24.



PEROSUCHUS FUSCUS, *Cope*.

Char. specificus.—Nuchal plates in a cross row of six; cervicals in four cross-rows, all of four plates except the last of two. Dorsal plates in six—in a few eight in each transverse row. No posterior crest on arm or leg. Tail short with remarkably low crest. Muzzle broad flat, without any ridges; its width at the eighth tooth entering 1.4 in length from end muzzle to anterior margin of orbit.

Description.—The specimen in the Museum of the Academy is young, measuring only 2 feet 5 inches in length. Of this the skull measures to the margin of the supra-occipital 2 in. 10.5 lihes; and the tail to the vent 13 in. 7 lin. From groin to heel 3 in. 2.5 lin., and the hind foot 3 in. 7.5 lin. The muzzle is a broad ovate, the sides rather more convergent anteriorly than in the Alligator *mississippiensis*. There is a thickening in front of each orbit, and

between them on the middle line another which together enclose two shallow concavities. Superciliary margins raised, the cranial table quite flat. The margin of the quadratojugal bone projects strongly. The scales of the limbs are all smooth, and those of the dorsal region with very low keels. The sides have four longitudinal rows of ovate scales separated by scarcely defined smaller ones. The abdominal plates are longer than broad, and are in twelve longitudinal rows. Dorsals in seventeen transverse series from interscapular to crural region. The lateral crests of the tail are only obtuse keels; they unite on the thirteenth annulus behind the vent inclusive. Color above dark brown, almost black on the upper surfaces of the head. The tail is paler, of a light olive brown. Lower surfaces everywhere bright yellow, including the entire lower jaw and margin of the upper. Eyelids and a band through ear yellow, the former with a black spot above.

Remarks.—This interesting addition to our knowledge of the Reptilia was made by Schulte Buckow of New York, while on a visit to the interior part of the course of the Magdalena river in New Grenada. This naturalist has also enriched our collections with other interesting vertebrata of that region, both living and dead.

OSTEOLAEMUS, *Cope.*

Proceed. Acad. Nat. Sci., Phila., XII, 550, 1860. *Halcrosia*, Gray Ann. Mag. Nat. Hist., 1862, 273.

As this genus has been variously understood, since its first publication, I take the present opportunity of quoting the original description, and adding such observations as are necessary to a full comprehension of the species embraced by it.

"Osteolæmus, Cope, was characterized as a genus of Crocodiles presenting several points of analogy to the Alligator. The nasal bones were prolonged anteriorly, and uniting with the short spine of the intermaxillary, divided the external nasal orifice, as in the genus Alligator. The eyelids were entirely osseous as in Caiman. There was no transverse bony ridge between the orbits. The dermal plates upon the tail, extremities, and the thorax, were more or less completely ossified; upon the gular region the ossification was most complete, the shields having a coarse natural articulation.

"The digits of the posterior extremity were very slightly webbed.

"Cervical plates distinct from the dorsal.

"Mr. Cope alluded to the remarkable extent to which ossification was carried in this genus. The cranium was much more rugose and pitted than in the adult specimens of much larger species, and the crotaphite foramina were roofed over by bone. The latter peculiarity was sometimes observed in the genera Jacare and Caiman.

"The osseous gular and thoracic buckler was also similar to that exhibited by those genera, and by the extinct "Crocodilus" Hastingsiæ Owen, the existence of which has been shown by Professor Huxley.

"Two specimens were exhibited: one a skin brought from the Ogobai river, Western Africa, by Mr. P. B. Du Chaillu; the other, the skull of a half grown individual, obtained from the Museum of the Pennsylvania University,

"These Mr. Cope regarded as belonging to a species hitherto unknown, and which he proposed calling Osteolaemus tetraspes."

Several descriptions of species of this genus have been published under different names. It is a matter of question whether all do not relate to one species. A young one was described by Murray, whose muzzle was of course much broader in relation to its length than in the adult. An adult was afterwards described by Lilljeborg with the relatively longer muzzle. It differed from that described by Murray in having but four rows of dorsal shields, and but two pairs of cervicals; in the latter there are three pairs of cervicals and six rows of dorsals. My type specimen, brought from the Ogobai by DuChaillu possesses six rows of dorsals, and only four cervicals, thus combining the characters of the two. Gray, however, who has seen Murray's type, says there are but four rows of dorsal plates; in the Ogobai specimen one row has but five, and in three others the two outer are nearly united; so I am disposed to think that no great importance is to be attached to this character. Murray's specimen has the relatively enlarged brain cavity of a young animal elongating the table of the cranium; Lilljeborg's, which is adult, maintains this character more than our specimens do. Gray gives a figure of the cranium of the adult, which coincides with two crania in our Museum, one of the above mentioned specimen, while both agree in the proportions of the muzzle with that described by Lilljeborg. The last, however, differs from all these in having the table of the cranium but little

wider than long; in our specimens and Gray's figure it is nearly twice as wide as long. It also appears that the nasal bones do not entirely divide the nasal meatus, which they do in the three specimens under observation. On the whole I am disposed to think that these forms belong to one rather variable species. It is true that Gray says "hind foot fringed," but this I am inclined to think must be true to a very limited extent. There is only a keel in our specimen, and Lilljeborg says there is no fringe in his.

OSTEOLAEMUS TETRASPES, *Cope.*

Proceed. Ac. N. Sci., Phila., 1860, 550.

Crocodilus palpebrosus, var. 2, Cuvier. Oss. Foss. iii., t. 2 f. 6 (part).
Crocodilus trigonatus (part) Curvier. Oss. Foss. iii., 65.

Fig. 25.

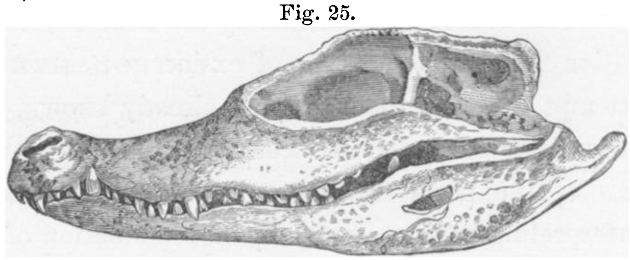
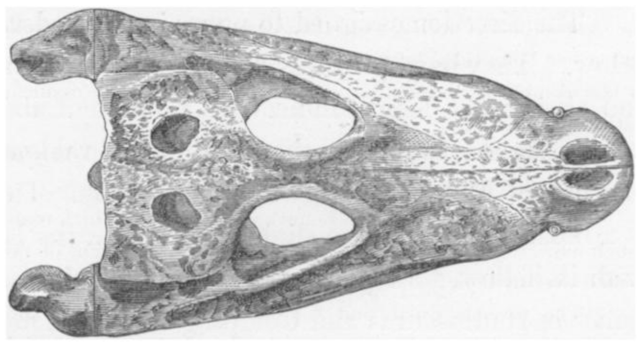


Fig. 26.



African Black Crocodile, Gray. Rept. British Assoc., 1862, Zool. Section, 107.

Osteolaemus tetraspes, Cope. Proc. Acad. N. S., Phila., xii., 550.

Crocodilus frontatus, A. Murray. Proc. Zool. Soc., 1862, pp. 139, 213, fig. head, t. 29, by Ford. Strauch, Syn. Cro., t. I., head (young).

Halcrosia frontata, Gray, Ann and Mag. Nat. Hist., 3d series, X., 277.

Halcrosia afzelii Lilljeborg. Proceed. Zool. Soc., London., 1867, 715.

Habitat, Gaboon Ogobai (Duchaillu).
Calabar (Murray), Sierra Leon (Afzelius).

This species was originally characterized as follows:

> Proportions of the head somewhat similar to those of Crocodilus trigonops, Gray, of India. Breadth of muzzle at ninth tooth equal to the distance between the external nasal orifice and anterior border of the orbit, and to the width of the table of the cranium posteriorly. A short ridge in front of each orbit, directed obliquely inward.

Teeth $\frac{17}{15}$, rather compressed. Four nuchal shields, in a single transverse series; four cervicals in pairs; Dorsal shields in six rows. Posterior extremities without fringe. Total length of the entire specimen, five feet.

In addition to the characters given above may be mentioned the strong concavity of the muzzle in the longitudinal direction, and the prominence of the nares. The margins of the maxillary are very sinuous, being much contracted behind the fourth and eleventh teeth. The derm of the head is thin and corneous, and divided into many segments, which have a fine sculpture of straight lines radiating from the centre in each. The bones of the cranium are very strongly pitted. Seventeen transverse series of plates between nape and posterior line of femora, 12 to union of lateral caudal crests, and 19 from that point to end of tail. Nineteen cross-rows of large plates from ankle joint to groin, on anterior face of limb. Counting similarly on the fore limb, there are 13 series. Only the two lateral dorsal keeled; keels of the outer of the first eight caudal annuli, low.

Color everywhere black; the plates occasionally with irregular olive lines. The young, according to Murray, have olive bands on a yellow-brown ground, including two bands of plates, and separated by two bands. Total length, five feet; muzzle to supraoccipital ridge, 8 in. 9 lin.; do. to posterior margin thighs, 2 ft. 7.6 in.

Gray supposes this to be the "Crokodil noir du niger" of Adanson, and hence cites as its earliest name *Crocodilus niger* Latreille. Dr. Strauch, however, shows that this is probably the *Crocodilus cataphractus* Cuvier, and I have pointed out that it cannot be the species of Latreille.

DINOSAURIA.

The ilium extended horizontally forwards, and supporting a number of vertebræ anterior to the two sacrals of other Reptilia. Acetabulum perforate, and partly enclosed peripherally by the ilium and pubis. Pubes elongate, parallel; ischia longitudinal, in plane of ilium, elongate, with distinct head for pubis. Femur with transverse neck and head, and third trochanter. "Cervical and anterior dorsal vertebræ with par and diapophyses, for articulation with bifurcate ribs." Neural arches of dorsal vertebræ attached by suture; of sacrals, shifted over the intervertebral sutures.

The structures presented by the Dinosauria have presented greater difficulty of explanation than any other type of extinct vertebrates.* This has in part resulted from the attempt so assign them to types already known, and to explain their structures in accordance therewith; a course scarcely consistent with our present knowledge of the peculiarities of the parts themselves. The type is a good illustration of the necessity of interpreting extinct forms by a combination of the "law of successional relation," with "the law of types" or of morphological "correllation," and not by either alone.

The direction assigned to pubes in this order, is suggested by considerations explained below. They have probably diverged forwards and downwards from the vertebral column and their great length indicates a prominent abdomen. The only Dinosaurs where they are preserved in place, the Stenopelix valdensis of Von Meyer, and Compsognathus longipes of Wagner, justify this proposition. The ischium in Stenopelix and Teratosaurus is a broad flattened bone slightly curved in the lateral direction, and of sufficient strength with its fellow, to support the weight of the animal when in a sitting posture. The pubes in Hadrosaurus and Compsognathus are much more slender and proximally dilated; as in the Crocodiles the chief support of each is derived from the articulation with an anterior tuberosity of the ischium. The articulation with the ischium is probably wanting or very slight and ligamentous, and the acetabulum was thus open, a large foramen being included by the three bones which usually compose it.

The head of the femur is transverse to the direction of motion of the condyles, and not oblique as in modern lizards. Hence the motion of this element was in a line parallel with the axis of the body, and the limb could not be directed obliquely from that axis so as to allow the body to rest on the ground between them in the ordinary progression of the animal, as is the case with Iguanas, Crocodiles, etc.

The fore limbs appear to have been weak, even when somewhat elongate, as in Iguanodon. Their articulation with the scapula is a singular part of the structure. In

* For discussions of these relations see Proceed. Ac. Nat. Sci., Phila., 1866, 317, and Proceed. Amer. Philos. Soc., 1869, 16.

Iguanodon and Hadrosaurus there is a very small sphaeroid condyle on the inner side of a broad proximal extremity. If the condyle only articulated with the scapula, the rotation of the humerus would be very limited; if the long narrow proximal articular surface, which is the whole of the flattened proximal extremity of this bone the rotation would be still less. In Laelaps however I find no round condyle, only the long narrow articular face of the proximal extremity, as in the Crocodiles. This would not allow of abduction and adduction, but as in the bird, of only flexure and extension. This is readily seen in the movements of the Crocodile. I suppose the anterior limbs were more useful as supports when these animals placed the head near the ground, than for any other purpose, especially in Laelaps and its allies.

The character of the articulation of the vertebral column by intervertebral discs, the double headed ribs, the elongate sacrum and large medullary cavities of the long bones have been cited by Prof. Owen in evidence of the Mammalian tendencies of the animals of this subclass. Their reptilian features, the single occipital condyle, quadrate and coracoid bones, with the median tarsal ginglymus, are equally shared by the Aves, though most of the usual distinctions between the latter class and the Reptiles hold good here also. Prof. Owen also points out a special bird-like tendency in the alternation instead of superposition of the neural arches of the sacrum on their centra; and other points can can now be added. Thus the reduction of the metatarsals to three in some of the genera, and their close approximation and excess of length over the phalanges, brings to mind these bones in the penguin. With the same reduction follows the confluence of the first series of the tarsal bones, and the great diminution of strength of the fibula and its close application to the tibia; the front limbs are much reduced, and the long bones more pneumatic. In the most extreme form in this direction known, the first series of tarsal bones is entirely confluent with the tibia as in the birds, the three metatarsals are much elongate, the cervical vertebræ increase in number, and the pubes assume a position at right angles to the vertebral axis, which is intermediate between their anterior position in most Reptiles, and their posterior, in Birds.

These features indicate three perhaps suborders, which are defined below.

Quite as important, as indicating the avine affinity and remarkable character of this order, is the evidence derived from the pelvis. And first, the support of this arch, the femur, has been already alluded to. The head and neck of this bone are at right angles to the direction of the condyle. In other reptiles the axes of these are oblique to each other, so that the femur does not move in the direction of the axis of the body, but obliquely to it, thus permitting the body to rest on the earth. In the present case the structure is the same as in the birds and Mammals; the femur could only move in a plane parallel with the axis of the body. The reduced length of the fore limbs of many Dino-

sauria, renders it impossible that they should have reached the ground, in progression, if the posterior were at all extended, and suggests that these reptiles walked erect. That this was the case is demonstrable from the materials at our disposal, I am inclined to believe.

The ilium, instead of having a vertical position as in reptiles, is longitudinal as in birds. That is, the small process which, in Lacertilians and Crocodiles, projects in advance of the acetabulum, is largely extended and developed, while the lower extremity of the posterior, or principal portion, is raised anteriorly, so that the two together constitute an elongate element, embracing not only the two posterior or original sacral vertebræ, but a considerable number anterior to them. The effect of this is to diminish the proportionate number of lumbar or dorsal vertebræ, to increase the length of the consolidated sacral series, and to throw the acetabulum, and consequently the femur farther anteriorly, and also farther upwards, than in the ordinary reptiles. All these features are characteristic of the birds, and have direct reference to an upright position. Thus it is readily perceived that the consolidation of the sacrum, is related to the need of a greater strength of support at a single point; its length, and that of the ilium, to the throwing forwards of that support to beneath the centre of gravity of the animal's body.

The very elevated position of the acetabulum, and consequently of the usual point of support of the pubes, renders it in the highest degree improbable that the latter bones had the usual direction and position seen in the reptiles. That is, an anterior position would not allow of space for the enlarged visceral cavity which these creatures probably possessed. But it is obvious that in most of the Dinosauria, if not in all, the pubes were not supported in the same manner as in most Reptiles. In Hadrosaurus and Iguanodon there appears to have been absolutely no point of union between ilium and pubis, and in Teratosaurus and Megalosaurus that union, if existing, must have been very slight. The ischia of Stenopelix, Hadrosaurus, and Iguanodon furnish the substitute for this, in an anteriorly directed process for the support of the pubis, a feature otherwise characteristic of the Crocodilia only, among reptiles.

I conclude, therefore, that the pubes were not directed forwards and that they were not directed backwards either, in those forms at least, where there is no preacetabular support for that bone. They must therefore have been directed downwards, and this is the position they have in the extreme avine form Compsognathus.

Such ischia as we are acquainted with, are of a remarkably elongate form, simulating those of birds rather those of reptiles, and indicating clearly the existence of a great pelvic visceral cavity.

From these considerations as to the extent of the pelvic elements we derive further, that the visceral cavity was mainly supported by them and that it was transferred so as to be

posterior to its position in ordinary reptilia. This, taken in connection with the anterior position of the support of the body—the femur, rendered the erect progress of the Dinosauria possible.

Another approximation to the birds will probably be found in the sternum and coracoids. These elements are but little known, and that imperfectly; the best example has been furnished by the great Teratosaurus suevicus Mey. Here, according to Plieninger, the elements corresponding to the xiphisternum of Lacertilia is a large thin shield-like bone, of elongate form. The coracoids are narrow, prismatic bones, and abut against the anterior angles of the xiphisternum; being entirely different from the broad flat element of the Lacertilia and other orders, which are usually extensively in contact with each other or with the xiphisternum.

We have, however, among Dinosauria, as among Quadrumanous Mammalia, a series of forms, from those constantly assuming the prone Lacertian position, to those that walked exclusively erect like birds. Perhaps the most Lacertilian form known is the genus Scelidosaurus of Owen: the greater equality in length of the limbs, and the numerous toes, as well as lacertilian dentition assign it to this place. Then we find forms like Iguanodon and Hadrosaurus, the most gigantic of land animals, where a semi-erect attitude was the natural one, as they like the Megatherium and Megalonyx, lived on vegetable food, and were necessitated to raise themselves on their hinder limbs to reach it. Here the bird-like type is approached, in the reduction of the metatarsi to three, and the great antero-posterior extent of the ilium. In the genus Laelaps the position was probably quite erect, and additional resemblances to the ornithic type are adapted to large animals no longer requiring a vegetable diet, but procuring their living food by activity and strength. They are accordingly organized so as to be entirely independent of extraneous support, and furnished with great powers either of running or leaping.

Intermediate between this extreme, and the type of Ignanodon, comes a large carnivorous genus, the Megalosaurus of Buckland, the representative of types like Laelaps, in the old world. In its longer fore limbs it differs from the most bird-like forms. A carnivorous type only known from teeth, is Aublysodon Leidy; it is American.

The other herbivorous species, of less size than Iguanodon, which was furnished with a dorsal series of dermal bones, is the Hylaeosaurus armatus Mantell, found in the Wealden of England; while an allied form which was covered with long massive dermal spines, has recently been discovered in the same formation in the Isle of Wight, and referred to the genus Polyacanthus Owen.

The sizes of the best known species of these genera are as follows:

	Length ft.
Polyacanthus, Owen,	9
Scelidosaurus harrisonii, Owen,	12
Iguanodon anglicus, Meyer,	28
Hylaeosaurus armatus, Mant,	21
Hadrosaurus foulkei, Leidy,	28
Poecilopleurum bucklandii, Deslong,	25*
Megalosaurus bucklandii, Mant,	?30*
Laelaps aquilunguis, Cope,	24
Teratosaurus suevicus, Meyer,	?30
Ornithotarsus immanis, Cope,	?35

Prof. Owen suspects the animals of this order to have had the septum of the ventricles of the heart complete as in the Crocodilia. It is an interesting inquiry whether there were two aorta-roots or only one, and if one, whether the right or left remained. I have little doubt that the Dinosauria further resembled Crocodilia in having the lateral lobes of the cerebellum developed, and the vermis plicate.

The affinity to the modern Sauria, or Lacertilia, which some authors have allowed of, is very slight; the Crocodilia, though somewhat removed, are the nearest living allies. If we consent to a derivative relation between types, we must consider this order to have given origin by divergence and metamorphosis to both the Mammalia and Aves. The structure and embryology of the last two classes forbid the idea that either could have been derived from the other.

Besides the differences in the structure of the tarsus and metatarsus observed in this order, there are marked differences in that of the tibia. Thus most of the order present a very prominent spine and crest, of bird-like character; but Plateosaurus Meyer and Teratosaurus Meyer both Triassic genera, appear to possess this character in a very slight degree, the former scarcely at all. I have, therefore, not included them in the groups following.

ORTHOPODA.

Cope Prcc. Acad. Phila., 1866, 317. *Therosauria Haeckel*, 1866.

Proximal tarsal bones distinct from each other and from the tibia, articulating with a tibia and with a terminal face of a well developed fibula. The ilium with a massive narrowed anterior prolongation.

In the few genera of this suborder, of which the teeth have been discovered, a successive divergence from the type of the Goniopoda is visible, in the shortening and increase in

* These estimates I have reason to think exaggerated.

number of the metatarsals. Thus so far as known, according to Owen, Hylaeosaurus Mant. had three closely approximate metatarsals. In Hadrosaurus they are elongate, but their number is unknown. In Iguanodon, Owen represents a fourth, but rudimental metatarsal, the hind foot being still three-toed, while in the more ancient genus Scelidosaurus, the same authority gives four shortened metatarsals, of which the smallest supports a digit; and a fifth rudimental metatarsus, which supports no digit. In Stenopelix there appear to be five digit bearing metatarsals according to Von Meyer.

This order is then probably divisible into the following families:

I. Teeth in several rows forming a vertical pavement; metatarsals ? three.

HADROSAURIDAE.

Embracing the genus Hadrosaurus, Leidy.

II. Teeth in a single row, cutting; three digit bearing metatarsals.

IGUANODONTIDAE.

Genera Iguanodon Buckl. Hylaeosaurus Mant. ? Palaeoscincus, Leidy.

III. Teeth in a single row, cutting; four digit bearing metatarsals.

SCELIDOSAURIDAE.

Genera Scelidosaurus, Owen. Stenopelix Myr. (? teeth). The last named genus is known from a single skeleton, in which according to Von Meyer, the sacral vertebræ are all distinct. It is perhaps an immature individual.

HADROSAURUS, *Leidy*.

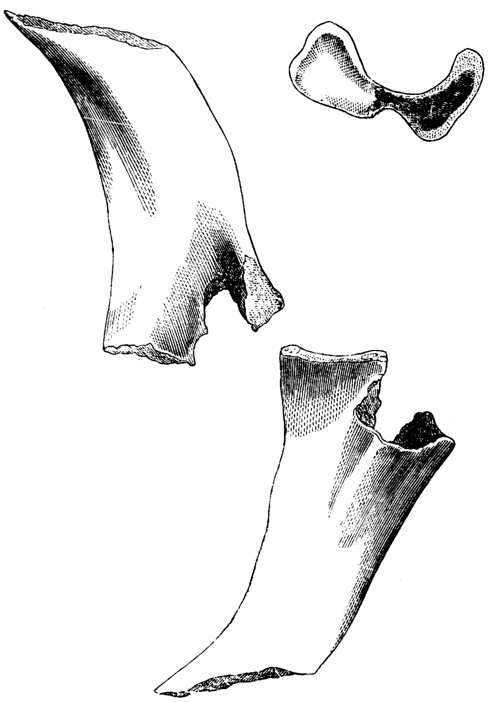
Proc. Ac. Nat. Sci. Phila., 1858, 218. Cretaceous Reptiles N. Am., 76. *Trachodon*, Leidy, L. C. 1856. ? *Thespesius*, Leidy l. c.

This genus embraces at least two species which are among the most gigantic terrestrial animals of which we have any knowledge. They represent the Iguanodon of the old continent, whose species is similar in bulk. The two genera, however, differ in many details. The teeth, as above noted, are different. The spines of the dorsal vertebræ, instead of being flat anteriorly, are smaller and slender subcylindric.

Most of the characters of this genus have been given by Leidy in his description of H. foulkii. I add a more complete examination into the characters of the scapular and pelvic arches, which are but lightly treated of in the "Cretaceous Reptiles of N. America."

Scapula.—Here may be introduced a description of certain massive bones of two individuals of a species of Dinosaur. I had formerly admitted the possibility of their pertinence to the pelvis of Hadrosaurus, but the discovery of that element in the H. foulkei, indicates that another place must be sought for them.

Fig. 27.



There was when the bone was complete, a double head, the anterior or superior apparently for articulation with the coracoid; the inferior, to receive the proximal end of the humerus, whose condyle is adapted to it both in size and shape. It is a flat bone curved in the direction of its plane, which is vertical, and narrowed distally, where it is broken off. It is expanded proximally into two heads of which the support of the inferior is in the general plane, while that of the superior is obliquely transverse to that plane: this head, which I believe to be the anterior and attached to the coracoid, is broken off. The inferior articular face is slightly concave; it is rugulose for an articular cartilage, and its plane is exactly transverse to the long axis of the bone. Its form would be vertically oval but for an expansion on what I suppose to be the outer side. The inner side is characterized by an obtuse longitudinal ridge, which extends upwards and backwards from the anterior head and soon disappears. A similar ridge is seen in the ischium of Crocodilia. As this ridge disappears from the inner side, a more obtuse one appears on the outer, and is in line with the subtransverse expansion of the neck of the anterior head; it soon reaches the posterior margin of the bone, which it thickens. Between this point and the posterior head, the margin is thin and acute. A more imperfect specimen of the same element from the same side (the right) of a rather smaller individual exhibits similar characters.

As compared with the scapula of Iguanodon, Hylaeosaurus and Scelidosaurus, a strong resemblance is seen in the marked distinction of the outline of the glenoid cavity, and the existence of a large distal depression of a subtriangular form. The anterior expansion is broken away, but from the indications at the fracture was probably well developed.

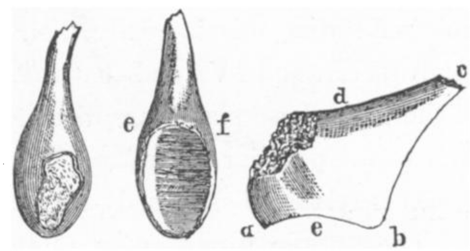
The proportions of the larger scapula indicate a gigantic animal fully equal to the known Hadrosauri; the humeral support agrees with that bone in the latter. The dimensions are as follows:—

	In.
Length of fragment on posterior margin,	13.9
Depth proximally (greatest),	7.2
" distally,	4

	In.
Depth of glenoid cavity,	3.4
Width " " "	3.16
" " anterior expansion,	4.22
" " fractured end,	1.8

Another fragment of an animal of dimensions similar to the last was found at the same time and at or near the same place, (Freehold,) in Monmouth county, New Jersey, but cannot be associated with the above described scapula, as neither the place nor time of discovery can be ascertained with sufficient accuracy. It appears to be the glenoid cavity of a scapula from which the blade has been broken off, and from which a short subconic procoracoid projects. The accompanying cut and measurements will furnish the requisite information respecting it.

Fig. 28.



	Inches.
Length from *a* to *b*,	5.54
" " *b* to *c*,	7.22
" " *d* to *e*,	4.71
" " *e* to *f*,	3.53

The fragment may belong to Mosasaurus.

Pelvis.—There is much difficulty in determining the true relations of the pelvic elements of these and other Dinosauria, owing to their unusual forms, our imperfect materials, and the discrepancies between authors.

Ilium.—One of our best clues is the skeleton of the Iguanodon discovered at Maidstone, and preserved on a block of rag, which has been described and figured by Professor Owen. The bones mostly preserve a normal though much disturbed relation to each other. An examination of the figure and description strongly suggests—

First, that the hooked superior prolongation of the ilium is the posterior, not the anterior, as described by Owen. This is confirmed by Owen's figure and description of the ilium and sacrum of the same species in Wealden Reptiles, Pl. III. (Iguanodon), where the thick hook-like process with its abrupt descent to the acetabulum, is also posterior.

The structure of Hadrosaurus, in which both caudal and lumbar vertebræ have been discovered, proves that this relation is the true one. The caudals have a greater transverse diameter than the lumbars, which are comparatively quite contracted from side to side. This is the reverse of what is usual among reptilia, where the caudals are usually

the most contracted. The wide caudals continue without contraction to the point where the tail reaches the ground. They then begin to elongate. The anterior vertebræ thus form a massive column, which no doubt supported the weight of these monsters. That the ischia performed this function in part in Lælaps, is evident not only from their more massive structure, but from the more elongate caudal vertebræ, while the still more slender caudals in the known Triassic genera, adds to the evidence derived from the ischia as to their use.

In the ilium of Hadrosaurus the slender hooked process and the expanded tuberosity both exist, and I am disposed to place the former posteriorly, and the latter anteriorly and externally as the most probably correct relation. This, moreover, throws posterior to the acetabulum, the more elongate articular face, where one might look for the ischiadic suture with propriety. This arrangement, however, presents the apparent anomaly of position, that the planes of the inner faces of the ilia are made to converge instead of diverge, thus rendering the interiliac cavity remarkably narrow. There can, however, be no doubt that this is really their position in Iguanodon, judging from Owen's figures (above), III. and IV., and that the sacral diapophyses really rest on the convergent faces of the ilia, whose planes are directed inwards as well as downwards. This adds still further to the peculiar ensemble of characters of these Dinosauria.

This relation has already been described as the true one, by Leidy.

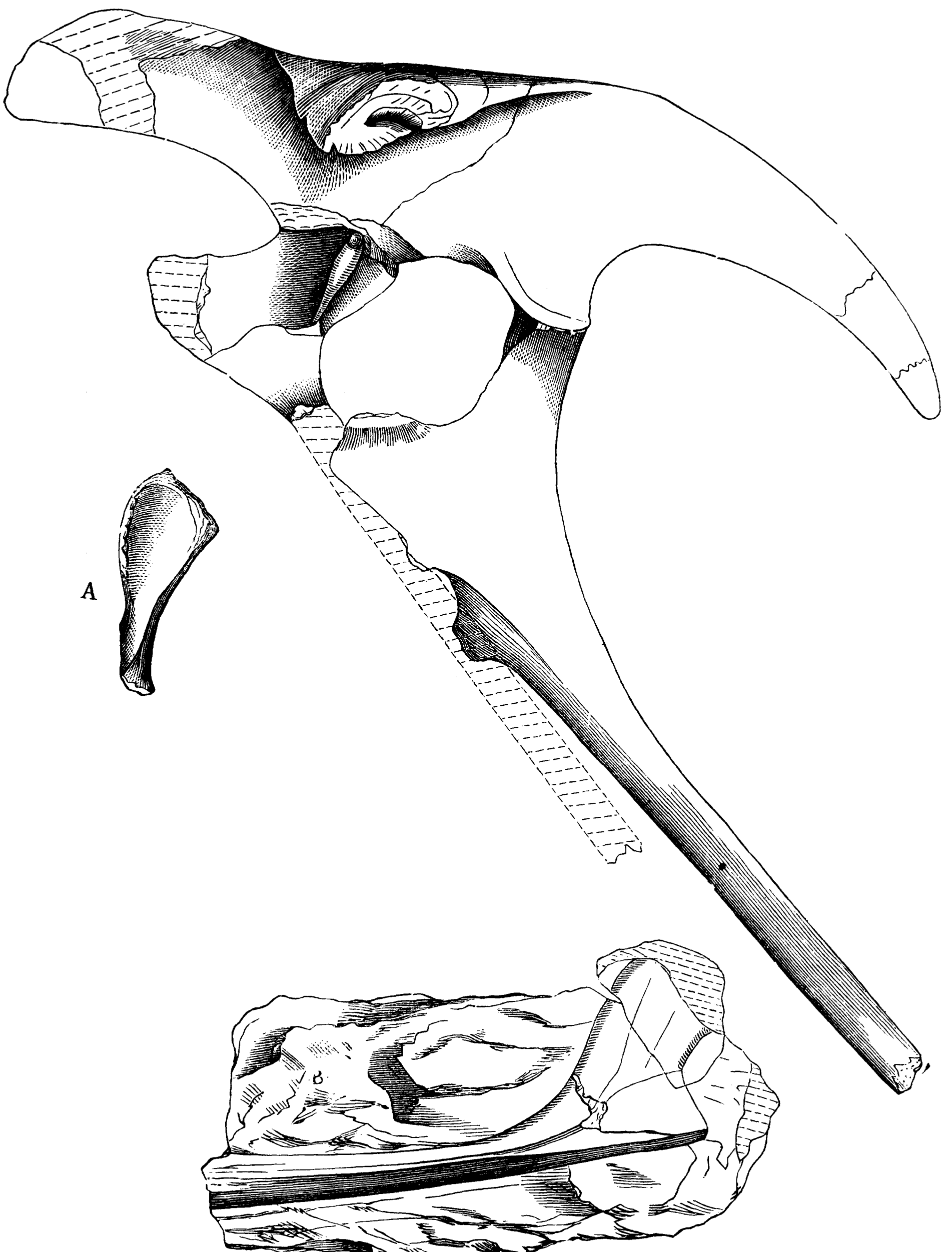
The anterior prolongation of the ilium in Hadrosaurus appears to be less slender and more plate-like than in Iguanodon and Scelidosaurus, where it is remarkably produced. Nevertheless, in the accompanying cut, the restoration (by Dr. Horn) of the anterior portion may be too much dilated, and is probably not long enough.

Pubis. This element of Hadrosaurus has never been described. I believe that I find it in a proximal portion of a large bone, which occupies this relation very appropriately. Its proximal superior subtriangular articular face is naturally associated with the already assumed anterior articulation of the ilium, and when so placed, presents outwards the smooth articular surface of the anterior part of the acetabulum. It also presents forwards a narrowed process, and in line with the same posteriorly, a broad, vertical plate which is soon broken off, but which I suppose to have been continued but a short distance. The posterior process I suppose has been continued as the support of a slender pubis,* conforming in this respect to the type of birds. That there is very little trace of articulation for ischium behind the acetabulum is obvious, so that it is to be supposed that this element was small, vertically dilated proximally, and in contact with the pubis at the superior processes on the supero-external margin of the latter.

* A suspicion which I at one time entertained, that the so-called pubis of the Crocodilia was homologous with the marsupial bones, has been removed, by reading Rathke's posthumous work on the development of the Crocodile.

	Inches.
Length iliac face pubis,	4.25
Width " " "	2.9
Entire depth,	7.5
Width pubic process where broken,	2.
" anterior process where broken,	4.6
" acetabular face,	3.4

Fig. 29.



Ossa ischia. These lateral elements are not very different from those identified by

Owen in Iguanodon with clavicles, and by Leidy in Hadrosaurus with the pubes. The Director in the British Museum has well pointed out the possibility of such a form of clavicle being probable, after a comprehension of the variations presented by the modern Sauria, and the not dissimilar form in Trachysaurus and Cyclodus. Leidy, however, is of opinion that similar bones in Hadrosaurus resemble rather the pubic bones of Iguana, and calls them pubes, with doubt. The writer sees a much greater resemblance between them and the elements called ischia by Wagner in the Compsognathus, and which are homologous with the posteriorly directed bone so called in birds.

It is noticeable that in the great Dinosauria the supposed clavicles do not diminish in length in the same proportion as do the humeri, as one would be led to expect were they clavicles. The relative lengths in three species are as follows :—

		Inches.
Iguanodon anglicus;	humerus,	35.
	os ischium,	29.
Hadrosaurus foulkii;	humerus,	22.5
	os ischium,	27.
Laelaps aquilunguis;	humerus,	12.
	os ischium,	20.

Their density and strength in the last named species are not readily reconcilable with the needs of such small fore limbs. Further, in Stenopelix Myr. and Compsognathus, where similar elements exist in the position of pubes and ischia, no clavicles have been preserved to us.

The more or less normal position in which these bones were found in the Maidstone specimen of the Iguanodon, as given in the figure accompanying Prof. Owen's monograph, has been already alluded to; the ilia were lying parallel with each other, their extremities similarly directed. The ischiadic bones lay across the ilia in their axes, the anterior dilated extremities lying not far from the position of the lost pubes, the posterior directed far behind the iliac crests, parallel to their axes. The similarity of position in both, and the preservation of relation between many of the other bones, renders it probable that their identification with ischia also indicates their natural relation.

The direction of the ischia is a difficult point to determine, but may be best understood by reference to those of Megadactylus and Clepsysaurus. In Hadrosaurus (see Leidy's plate in Cret. Rept. U. S.) this bone consists of a long slender subcylindric shaft with dilated extremity. The dilated portion thin, a part in line with the shaft and truncate, and

separated by a concave margin from a larger portion at right angles to the shaft. The latter bears an oblique surface for fixed articulation at its extremity.

In Megadactylus,* the distal portions of the ischia are united on the median line for a considerable distance, and are styloid in form. This portion is evidently distal, from the lack of articular faces and the divergence and flattening of the other extremities. They also resemble the distal extremities in Compsognathus. In Clepsysaurus, the shaft and dilated extremity are both preserved. The former resembles that of Megadactylus, the latter that of Hadrosaurus in some degree. If the shaft be posterior, the other extremity is anterior, and the larger dilatation extending at an angle to the shaft supports, no doubt, the iliac articulation. The trihedral shaft indicates a median line of junction. In Hadrosaurus no part of the shaft presents a face for contact with that of the other side, while in Lælaps such face is very distinct and elongate. From the above, I suppose that the larger extension of the ischium is superior and bears the iliac articulation, that the concave anterior outline is that bounding the acetabulum, and that the lower dilatation was in contact with but not united to the pubis. This is the more probable, since it agrees nearly with the arrangement in Iguanodon, as pointed out by Huxley.† It cannot be denied, however, that the supposed iliac articulation in the ischium in Hadrosaurus, bears a remarkable similarity to the median suture presented by the union of the two supposed ischia on the middle line below and distally, as in the pubes of Struthio. In that case, they would be pubes. In a posterior direction and median approximation it will agree also with the known pelvic elements of an interesting Saurian described by Von Meyer (Palaeontographica) from the Wealden of Germany, the Stenopelix valdensis. No attempt has been made, so far as I am aware, to refer this animal to its place. It appears to me in its vertebral and pelvic features to be a small Dinosaur allied to Scelidosaurus Owen. The ischia, however, are remarkably prolonged posteriorly, and find a parallel in Compsognathus Wagn.

Believing them to be ischia, the inferior pelvic arches of Hadrosaurus were light and slender, the ischia parallel and light, and entirely incapable of supporting the weight of the animal, as was done by Megadactylus. The tail was no doubt the great support when the head was elevated.

* The large pneumatic foramina in the vertebræ of this genus, together with those seen in the sacrum of Lælaps, explain the character of similar vertebræ described as os quadratum of Iguanodon by Mantell and Owen, and sacrals of Hadrosaurus by Leidy. I regard the latter as indicative of a new genus allied to the Goniopoda.

† Opportunity of reviewing this part of my essay having offered, I must point out the confirmatory evidence I have derived from Prof. Huxley's recent explanation of the structure of Hypsilophodon, with regard to my determination of the pubes in Hadrosaurus. He proves conclusively its *posterior* direction, which view I adopt for Hadrosaurus, contrary to my former supposition.

The figure 29 is the result of the preceding considerations, but it is not to be considered as completely demonstrated. They all go to show the narrow and prominent form of the abdominal region, which was associated with its posterior position, and the great lengths of the femora. Fig. *a* is a front view of the pubis; *b* is an internal view of the ischium of Clepsysaurus.

Dentition.—The teeth of this genus are very much smaller in relation to the size of the animal than in Iguanodon. They bear enamel on one surface only, the external for the inferior series as Leidy points out. Thus but one edge of the worn crowns is enamelled, and acts functionally like that of the anterior faces of the incisors of Rodents. They produce shear-like edges, cutting the vegetable food by a horizontal transverse motion.

HADROSAURUS MIRABILIS, *Leidy.*

Proceed. A. N. Sci., Phil., 1868, 199.
Trachodon mirabilis, Trans. Am. Phil. Soc., XI, 1860, 140. Tab.
Upper Jurassic Bad Lands of Judith River, Nebraska.
Known from teeth, and perhaps vertebræ and phalanges.

HADROSAURUS FOULKII, *Leidy.*

Proc. Acad. Nat. Sci., Phil., 1858, 218, Cret. Rept. U. S. 76, Tab. XII to XVII.
Cretaceous green sand, New Jersey.

There are eight localities in the green sand of Cretaceous age in New Jersey, from which I have seen portions of this species.

HADROSAURUS ? OCCIDENTALIS, *Leidy.*

Thespesius occidentalis. Trans. Amer. Philoso. Soc., XI., 1860, 151, tab.
? Cretaceous Beds of Nebraska, between Moreau and Grand Rivers.

Of this supposed species, Leidy says, "Had the remains of *Thespesius* and *Trachodon* been found in a deposit of the same age, I should have unhesitatingly referred them to the same animal, and I cannot avoid the suspicion that future investigation may determine them to be the same." In this he refers to Hadrosaurus mirabilis, which Hayden discovered in the Jurassic of Judith River, while the types of *Thespesius* were found by the same geologist, in a bed with other vertebrates, mostly reptiles, which he determined to be of Miocene age.

Now, the extreme improbability of this type occurring in a Miocene bed will occur to many palaeontologists, as has to me. With the view of determining this point if possible, I instituted an examination of the forms brought by Dr. Hayden from this locality, and first of that most characteristic animal, the *Ischyrotherium*, of Leidy. This, as has appeared in the preceding pages, I believe to be a reptile, allied to Plesiosaurus, a conclusion which at once establishes the Mesozic age of the bed. It coincides with the presence of Hadrosaurus, in indicating Cretaceous or upper Jurassic age.

As Leidy has referred the eastern and western herbivorous Dinosouria to one on the same genus, and as there is much doubt as to whether the present animal is not one of them, I refer the latter here as an expression of the probabilities of the case.

PALAEOSCINCUS, *Leidy.*

This herbivorous genus is, as remarked by its describer, an interesting representative of the Hylaeosaurus of the European Wealden.

PALAEOSCINCUS COSTATUS, *Leidy.*

Tr. Am. Phil. Soc., 1860, 145.
Upper Jurassic Bad Lands of Judith River, Nebraska.

ASTRODON, *Johnston.*

Amer. Journ. Dent. Sci., 1859.

ASTRODON JOHNSTONI, *Leidy.*

Cret. Rept. U. S., 102, Tab.
Cretaceous greensand, Maryland, (near Bladensburg.)

To a genus nearly allied to the present, should be referred the animal represented by a large tooth discovered by Thomas Wright in the Island of Wight, described and figured by him in the Annals and Magazine Nat. History, 1852, p. 89. The creature has been of larger size than the *Astrodon Johnstoni*, and apparently of a formidable nature.

GONIOPODA, *Cope.*

Proceed. Ac. N. Sci., Phila., 1866, 317.
Harpagmosauria Haeckel, 1866.

Proximal tarsal bones distinct from tibia; the latter closely embraced by the much enlarged astragalus, on its inferior and anterior faces, forming an immoveable articulation. Astragalus, with an extensive anterior articular condyle below, above in contact with the fibula, which is much reduced, especially distally. Anterior part of the ilium dilated, and plate-like.

This group is named from the abrupt flexure of the ankle in the middle of the tarsus, preventing the foot from being extended in line with the leg.

It represents no doubt an early stage of developement of the Symphypoda, and is remarkably similar in the same points in the structure of the posterior extremity, to the embryo of the chick at about the ninth day. At that time the metatarsals of the bird are distinct, proximally joined by a single tarsal element, which itself is separated by the articulation from a transverse piece composed of the confluent proximal tarsal series. The latter element is not at this time united with the tibia, but it is in contact with the fibula.

The fibula in latter stages withdraws from this connection, and becomes much shortened and reduced.*

The genera which belong to this order are,

Laelaps, Cope;
Poecilopleurum, Deslongchamps;
Megalosaurus, Buckland;
Coelosaurus, Leidy;

and perhaps,

Bathygnathus, Leidy;
Aublysodon, Leidy.

LAELAPS, *Cope.*

Proc. Acad. Nat. Sciences, 1866, p. 275; l. c., p. 316; l. c. 1867, p. 234. American Naturalist, 1867, 27. *Dinodon*, Leidy, Proc. A. N. Sci., 1868, 298, not Ibid., 1856, and Transac. Am. Phil. Soc., 1859.

LAELAPS AQUILUNGUIS, *Cope.*

Loc. Cit. Leidy. l. c. 1868.

This species was described by the author from a number of bones and fragments derived from the top of the "chocolate" stratum of Cook & Smock's upper bed of the Cretaceous Greensand of New Jersey, at a depth of about twenty feet below the surface. They were found by the workmen under direction of J. C. Voorhees, Superintendent of the West Jersey Marl Company's pits, about two miles south of Barnesboro, Gloucester co., N. J. The bones preserved were portions of the under jaw with teeth, portions of the scapular arch, including supposed pubes two humeri, left femur, tibia and fibula, with numerous phalanges, lumbar sacral and caudal vertebræ, and numerous other elements in a fragmentary condition.

The discovery of this animal filled a hiatus in the Cretaceous Fauna, revealing the carnivorous enemy of the great Herbivorous Hadrosaurus, as the Aublysodon was related to the Trachodon of the Nebraska beds, and the Megalosaurus to the Iguanodon of the European Wealden and Oolite.

In size this creature equalled the Megalosaurus bucklandii, and with it and Aublysodon, constituted the most formidable type of rapacious terrestrial vertebrata of which we have any knowledge. In its dentition and huge prehensile claws it resembled Megalosaurus. The species is now rediscribed with additional observations and with figures.

? Zygomatic arch.—A portion 6.5 inches in length is perhaps the malar portion of the arch rather than the squamosal, since near the termination of its inner or concave face it is pierced by a large foramen, similar in position to the suborbital foramen. The bone is slender, chiefly strengthened by a strong external, horizontal ridge, which is probably the homologue of that noticed by Prof. Owen as dividing the face of the maxillary and malar in Scelidosaurus. Alone and below this rib, the bone rapidly thins away. There is little curvature, indicating a long slender zygoma perhaps as in Compsognathus. The foramen has not been closed above.

	Lines.
Vertical depth inside of front of foramen,	18
Horizontal depth zygoma,	15

Maxillary bone.—A portion of the right maxillary displays parts of four alveolæ: three of these have a flattened oval section, while the anterior is round, suggesting the presence of a canine-like tooth. One successional tooth in place extends from the bottom of the alveolus to within .75 inch of the maxillary border; it stands obliquely in place,

* See Gegenbaur, l. c.

the posterior cutting edge being directed outwards. The anterior alveolus is shallower than the second, and this shallower than the third, which gives an oblique slope to the fractured margin of the bone, and suggests the application of another skeletal piece. This I suppose to be the premaxillary, as the bone is externally too flat to permit the median premaxillary suture to occupy that position. The upper portion may be related to the margin of the nares. A series of five foramina extends along the outer face of the bone opposite the middle of the depth of the alveolæ. The alveolæ are directed more anteriorly from behind forwards.

	Lines.
Depth of alveolus,	34
Length crown of successional tooth,	25
Length piece embracing four alveolæ,	61

Mandible.—One portion from the anterior part of the ramus. The latter measure three inches in depth from the outer alveolar border, which is a little more elevated than the internal, and 1.5 in. in thickness at the fractured edge. A longitudinal series of vascular foramina extends along the middle of the external face. The teeth are implanted in deep alveolæ, and had transversely oval compressed fangs; the sections of the crowns of teeth from different portions of the ramus differ. Two from the anterior region are considerably recurved, the concave or posterior edge deticulate to the base of the enamel, the anterior aspect minutely serrate, two fifths the length from the tip. Section at this point lenticular, lower down the anterior face becomes broader and rounded, giving a rounded cuneiform section. Throughout, one face is more convex than the other. A young posterior tooth yet in the alveolus (no. 3) is less recurved, subacute, and of more lenticular section, having both edges denticulate to the base of the enamel. Fangs hollow, the pulp cavity capacious but rapidly diminishing and short; the cast sulphide of iron and marl.

		Inches.
No. 1;	total length (fang broken),	2.33
	length of enamel,	1.83
	width below,	.833
	anterior diameter,	.438
No. 2;	length of crown (tip restored),	1.875
	anterior diameter,	.5
No. 3;	length of crown,	2.125
	width at base,	.688

Larger teeth are indicated by fragments. The development of the teeth has apparently proceeded as in Megalosaurus. The development of the dental papilla takes place within a niche of the alveolus, between it and the inner mandibular or maxillary wall. Small serate casps are found in this position beneath but a thin stratum of bone. In one situation a second successional tooth occupies a position between the primary cusp and the functional tooth, and is about intermediate in size between them. These successional teeth then increasing in size, by a horizontal movement, transverse to the cranial axis, place themselves close to the fangs of the functional teeth, into whose places they gradually rise. An absorption of the dental wall probably prepares the older tooth for shedding, at which time the apex of the successional tooth is ready for use.*

Vertebræ.—No cervical or dorsal vertebræ were preserved; we have only as yet sacrals, and numerous caudals. All are much constricted medially, or hour-glass shaped, the centrum cylindrical in section throughout in most of the caudals, the anterior of the latter and the lumbars of deeper vertical than transverse diameter throughout. The articular surfaces are moderately shallow biconcave in all, most strongly in the subproximial caudals. The neural arches attached by permanent suture, and inferior surfaces for articulation of chevron bones. The caudals offer indication of neural spines; their traces are on the majority low, and of considerable longitudinal extent. Articular

* Deslongchamps figures a tooth as doubtfully belonging to Poecilopleurum. It resembles that of a Crocodilian, and probably belongs to a species of that subclass. He states that Megalosaurus-like teeth occur in the strata in which Poecilopleurum was found. There is now much reason to believe that the latter are the true teeth of the genus in question.

surfaces for chevron bones were much narrowed anterior to the middle of series, so that we can infer that the tail was proximally cylindrical. Zygapophyses turned upward, not outward.

The portions of the three sacrals preserved indicate that the centrum is very much compressed, as in other Dinosauria. The proximal caudals, or those with diapophyses, have also compressed centra, though this is less marked than in the sacrals. The diapophyses come off from the neural arch above its union with the centrum in four such vertebræ preserved. In these the arch is not coössified. In the remaining nine there is no trace of diapophysis beyond a ridge visible in the anterior ones, and the arches are coössified. In the four anterior there is on the posterior half of the median line below, a strong groove ; in the two median, a foramen penetrates the centrum ; in the posterior the groove is less posterior in its position. In the posterior series of ten it is represented by an indistinct plane. These vertebræ are relatively less compressed than the first, but have a more concave inferior outline. The neural spines of these have been apparently curved upwards and backwards, judging from the direction of the lines of ossific growth, as in Poecilopleurum. They originate a little anterior to the middle of the length of the vertebra. Anterior to this point the neural canal is only partially roofed over, there being an opening into it just in front of the base of the neural arch. Anteriorly the roof would appear to be composed by the union of two horizontal laminæ of the anterior zygapophyses. The articular faces for chevron bones are small.

		In.	*Lin.*
Dimensions of an anterior caudal;	length centrum,	4.	3
	depth do. from suture of neural arch,	4.1	0
	width articular face (anterior),	3.	6
	" centrum at middle,	2.56	0
Length of median caudal,		4.625	
Breadth centrum,		2.375	
Length base neural spine,		3.25	
Length of a distal caudal (with neural canal),		2.875	
Diameter centrum transverse,		1.125	
" " vertical,		.875	
Proximal caudal (with short diapophysis) length,		4.5	
Depth centrum,		3.125	
Width "		3.	

Three separate vertebræ appear to be most probably sacrals, and indicate that this individual was not adult. Their form is much compressed, and the articular surfaces are rather expanded and concave. The superficial layer of the latter is very thin, and covered with delicate raised striæ, mostly transverse in direction. They present the appearance of incomplete development, and would no doubt at a later period coössify with those of the adjacent vertebræ, forming the long sacrum common to the order. Their exterior dense walls are remarkably thin, and the internal structure of the centra is coarsely spongy or almost cavernous, being far less close and compact than that of the cancellous centra of the caudals. The largest of these has a strong median groove above, probably that of the neural canal: greatest elevation of articular surface 5 in. 2 lin., greatest width of same 4 in. 2 lin. The tissue of this centrum is so coarse as to resemble the borings of Teredo. In another a large foramen marks the mouth of a canal which enters the centrum just behind one of the articular surfaces, and above the thickest portion of the centrum. It descends obliquely towards the middle of the centrum, but its course can be traced only an inch. Foramen .9 inch in diameter.

The number of caudals preserved is fourteen. From interruptions in the series I imagine that ten have been lost, probably a few more; I think the whole number can be estimated at twenty-five. Both distals and proximals are preserved; the former are small and slender, the latter compressed, similar to the sacrals, and with diapophysis, and neural arch not coössified.

This furnishes a remarkable contrast to Hadrosaurus, to which Leidy reckons fifty-vertebræ, and a depth of tail of a foot and a half.

*They thus resemble in several ways, the bone referred by Mantell and Owen to the place of the os quadratum, with doubt. There is little probability to my mind, of this reference proving other than erroneous; see the fig. in Pl. XI at the end of the volume.

In comparing this series with those of Poecilopleurum, so well illustrated by Deslongchamps, it is observable that vertebræ of similar proportions in the two are without diapophyses in the former, while they possess them in the latter. Thus the diapophyses probably cease at a point in Laelaps anterior to the same in Poecilopleurum. It is also noticeable that while they are obliquely directed backwards in the latter, those having them as well developed in the former exhibit them transverse.

Humerus.—Both are preserved, but lack the distal condyle; about half the coronoid fossa of one remains, furnishing an indication of the breadth of that extremity. They are proximally much dilated, having a very strong postero-external ala and a shorter antero-internal dilatation. They are not half the length of the femur; the shaft is flattened antero-internally. Of the proximal articulating surface a portion is lost, but a narrow surface continuous with it externally does not extend further out on the dilatation than opposite to the middle of the shaft. I find no trace of a globular condyle, as is seen in Hadrosaurus. Coronoid fossa large and well marked, not near to penetrating; medullary cavity of shaft relatively smaller than in the bones of the leg.

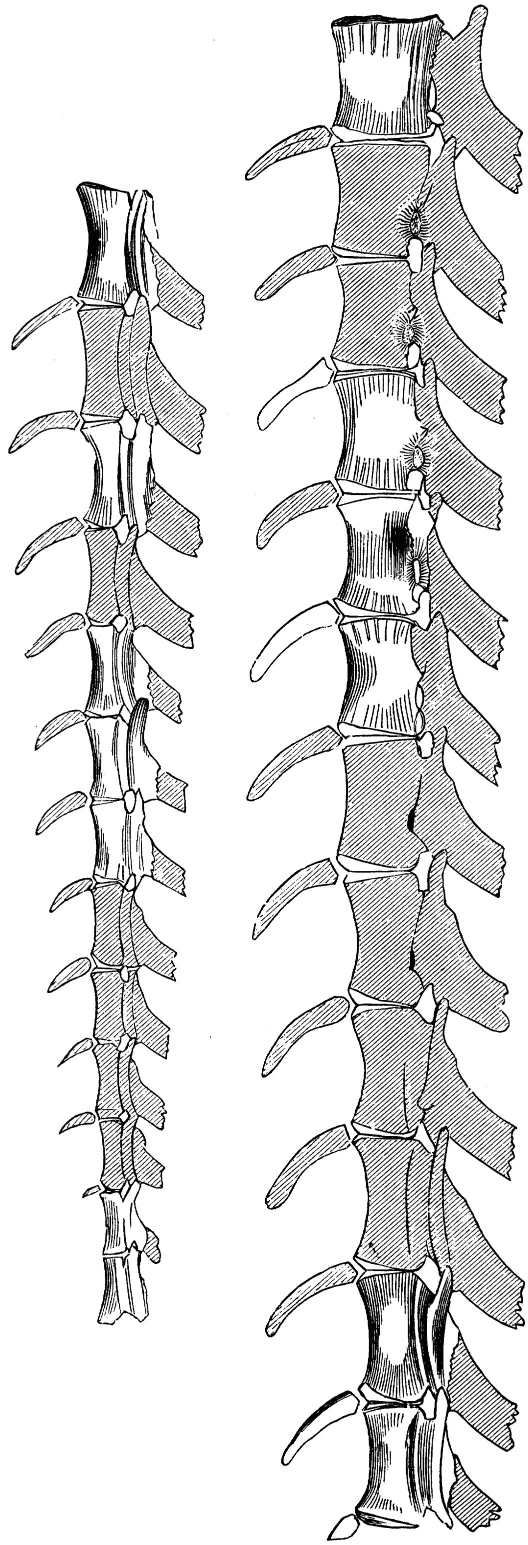
	In.
Length of humerus (restored),	12.
Greatest proximal breadth,	3.75
Distal breadth across coronoid fossa,	3.
Circumference of shaft,	$5.\frac{3}{8}$

These humeri are relatively shorter than in Hadrosaurus and Iguanodon, and the external alæ do not pass so abruptly into the shaft as in them. They resemble most those of Poecilopleurum. They differ from these in being much dilated distally, especially internally, and in having the coronoid fossa much more pronounced.

Fore-limb.—In the lack of the necessary pieces, one cannot go far wrong in estimating the length after that of Poecilopleurum. In it the lower arm is three-fifths the humerus, which gives for Laelaps a length of 19.2 in. to the wrist. If we accept the Crocodile as the next nearest ally in the fore-limbs, we find the carpus and hand to be .75 of the humerus. The ungueal phalange preserved in Poecilopleurum is shorter than in the Crocodile; if however we add 9 inches to the length already estimated, we have for the whole 2 ft. 4·2 inches.

This is, as will be hereafter shown, a little more than one fourth (1-3.71) the length of the hind limb.

Fig. 30.



Left Femur.—The head and summit of the great trochanter, and the posterior portions of the condyles, are broken away. The shaft is rather slender, and is strongly arched forwards and slightly outwards. The third trochanter is on the posterior face, is turned inwards, and marks one-third the length of the shaft from the supposed position of the head. Just below it the shaft is cyclo-trigonal, while for a short distance above the condyles it is flattened anteroposteriorly. It is strongly concave between the condyloid ridges at the distal end. At this place the external face is convex, the internal concave as high as a point a little more than a fourth the total length. The concavity is separated from the anterior face by a strong ridge which is partly broken away. The anterior surface is turned posteriorly to the external condyle, while it is concave and turned forwards to the internal condyle.

The posterior portions of the two condyles are broken away, so as to give their remaining portions almost exactly the form of the head of the femur in Hadrosaurus and Iguanodon. The dense layer of the remaining portions is much worn away, but enough remains to show that the external was rather the more prominent. The trochlear and popliteal concavities approach much nearer together than in Megalosaurus, causing a greater attenuation of the basis for the condyles. It cannot be ascertained whether the external condyle bore the small process behind seen in Megalosaurus.

The neck is much compressed anteroposteriorly, and extends much interior to the line of the shaft. The posterior face is regularly convex, and then turns into the transversely convex exterior, which is divided above by the groove that separates the external trochanter. The broad posterior face narrows below this trochanter, and presents a strong convexity posteriorly, opposite the upper portion of the third trochanter. The outer trochanter has a flat anterior face, and presents a sharp margin inwards. It is separated from the neck by a deep longitudinal concavity. It is probably much shorter than the head of the femur, about as in Megalosaurus.

	In.
Length of femur restored,	35.5
" actual,	32.
Transverse extent of condyles,	6.45
Posterior breadth of neck,	6.5
Anterior " of great trochanter,	3.25
Diameter neck and " "	4.5
" anterior groove between them (medially),	1.5
Circumference shaft at middle,	11.

This element, compared with that of Megalosaurus, differs in its considerably more slender form, and in its curvature. The femur of the latter genus is very stout, and has a straight axis. The posterior prolongations of the condyles are broken away, but if the external were as small as in Megalosaurus, it was more external, and the popliteal concavity not so abruptly distinguished from the posterior face of the shaft above. This extremity of the bone more nearly resembles that of the Poecilopleurum bucklandii, described and figured by Deslongchamps.

In my original description (Proc. A. N. Sci., 1866) I reversed the position of this bone, I believe incorrectly, which has been observed by Leidy. As it stands broken, the distal extremity is almost identical with that of Hadrosaurus, and the proximal with the trochanter furnishes a very good basis for condyles like those of Megalosaurus; hence the error.

The relative lengths of the femur and humerus of certain genera of this order may be compared as follows:—

	Humerus.	*Femur.*	*Proportion.*
Iguanodon anglicus,	19	33.	.575
Hadrosaurus foulkei,	22.5 in.	41.5	.54.2
Laelaps aquilunguis,	12 in.	35.5	.33.8
Poecilopleurum bucklandii,	13	38	

Left Tibia.—The tibia is more slender than that belonging to Megalosaurus described by Prof. Owen, and the distal articular surface, instead of being lozenge-shaped, is cuneiform, the inner wide extremity oval rounded. Inner transverse breadth of proximal head one fourth total length. Anterior crest very strong, much incurved, disappearing at between the proximal fifth and fourth of length; internal ridge on proximal half, strong, but not reaching

condyles. Posterior condyles separated by a deep notch, inner larger than outer (outer larger, Megalosaurus bucklandii). Shaft much compressed from before backwards, and distal articulation at right angles to proximal, concave on its interior half. On the exterior face a strong crest extends along the proximal fourth of the length, not reaching the head, which is the point of contact of the slender fibula, and is similar to the same in birds.

	In.
Length of tibia,	30.75
Circumference proximal head,	15.
Anteroposterior diameter do.	7.5
Posterior transverse do. do.	5.5
Transverse length distal condyle,	7.
Longitudinal inner breadth,	2.5
Circumference of shaft at middle,	10.5

These long bones are hollow, with thick walls of dense bone; diameter of medullary cavity at middle of tibia 1.5 inch.

Left Fibula.—Twenty-four inches preserved, proximally concave and dilated; condyle curved, narrow acuminate oval, in profile concave, then rounded descending; length 6 in., median breadth 1.75 in. Just below the condyle on the inside is a deep concavity with abrupt superior and lateral walls. Shaft less flattened below, but slender, reaching a width of 1⅛ in. The fragment which occupied the most distal position which is preserved, is rather less flattened, but quite convex on the outer face. It is not very unlike in general form the fibula of the ostrich, and like it is continued to the tarsus, closely applied to the tibia. Its proximal half lies on a ridge of the tibia in Laelaps, but when the distal end of the latter expands, the fibula continues directly across the expansion, appressed to the anterior face, in a shallow groove.

I have given the fibula a relation the reverse of that assigned to Hadrosaurus and Iguanodon by Leidy and Owen respectively, that is, I consider their inferior extremity the superior, and vice versa. This relation is coincident with their bird-like affinities, which require a restriction of the fibula distally, not proximally. It also furnishes the requisite extent of articular surface for the condyles of the femur in Laelaps and Hadrosaurus, as well as in Scelidosaurus, according to Owen's plate. The head of the tibia, alone, is too narrow for the femur in the two genera first mentioned. This structure accords also with Compsognathus, where the fibula is reduced distally.

Tarsus and Metatarsus.—The distal extremity of the tibia is transverse, and much compressed, and does not exhibit any of the usual appearances of an articular surface, neither the reptilian condyle, nor a cotyloid cavity sufficient for an astragalus of the size necessary for an animal of such bulk. A bone, presenting a broad hour glass faced articular surface was discovered with the other remains, and had puzzled the anatomists who had seen it. This piece exhibits along its whole posterior aspect two faces, which form a reëntrant angle for a fixed articulation: this is found to have been applied to the extremity of the tibia exactly, and to have been fixed by strong articular ligaments. The medially constricted condyle presenting forwards and a little downwards exhibits an unusual modification of the vertebrate astragalus.

The fibula presents a long and narrow articular surface at the knee, and fitting the tibia by the concavity of its inner face, becomes greatly attenuated at its distal third, where it is, in consequence of an obliquity of its direction applied to the anterior face of the former bone. It may then be supposed to extend to the outer margin of the astragalus, and terminate at the small calcaneum which embraced the outer anterior extremity of the tibia, like an epiphysis. In applying the astragalus, we see that a process projects from its superior margin, which when applied to the face of the tibia occupies with its flat inner face a shallow longitudinal concavity of that bone. This concavity continues across the external expansion of the same, and is continuous with its outer margin in direct line with the position of the fibula. The continually increasing slenderness of the tibia as represented by a large fragment of its distal portion, renders it extremely improbable that it spanned the concave outline of the tibia, to be in contact as in reptiles, with the distal extremity of the tibia, in the usual position of the malleolus, especially as there is no face for contact on the latter. Continued from its point of obvious contact with the external margin of the tibia, it falls nearly into the shallow groove mentioned and into the line of the ascending portion of the astragalus. The latter is broken off at the extremity, but presents a form not very different from the broken slender end of the fibula, and is of about the same size.

A reasonable inference is that they were continuous, and I have taken this view. (Proc. Acad., 1866, p. 316.) There is however an objection to this position. One is that the astragalus does not extend across the entire end of the tibia, and presents a smooth surface, perhaps an articular, at its outer extremity. This must have been in contact with a small astragalus or with a malleolar extremity of the fibula. The thin external expansion of the tibia could support but little weight, and as the condyloid convexities of the astragaloid piece are nearly equal, there would seem to be little need of additional condyloid face. Should however the fibula have descended to this point, its course must necessarily have been alongside the ascending process of the astragalus, but not in contact with it. There is no trace of such contact, as the process presents externally an obliquely rounded surface, ending in an angular margin with a posterior flattened face.

Two other examples only of this structure are known in the vertebrata, one of which I find mentioned in Cuvier Ossemens Fossiles, X, p. 204, Tab. 249, fig. 34–5. This author studied the distal extremity of a tibia with applied condyloid astragalus, from Honfleur, which he was not able to assign to any known species or genus, but which he, with usual sagacity, includes in the chapter devoted to Megalosaurus. He however regarded the face of the tibia receiving the condyloid bearing bone, as the inner, instead of the anterior, stating that the tibia is laterally instead of anteroposteriorly compressed, so anomalous is this structure among vertebrates. He regarded the bone as the astragalus, and did not perceive any connection between its anterior ascending apophysis and a fibula, partly because a fibula with distinct distal articulation was received with the same bones.

Gegenbaur's demonstration of the nature of the ankle joint among birds and reptiles at once makes the nature of the present case clear.*

This tibio-tarsal bone possesses an articular facet on its exterior extremity, probably for conjunction with a calcaneum which supported a small second row tarsal and perhaps rudimental metatarsal and phalange. Its plane is transverse and does not cover the whole extremity, the anterior margin and a knob on the anteroposterior part of the extremity projecting beyond it. Exterior to the middle of the upper margin of this piece and at the internal base of the ascending apophysis, it is perforate, as is the cavity above the condyles of the humerus in the higher apes, and may have received a similar coronoid process of a scaphoides.

As compared with the species examined by Cuvier, this astragalus has a less elevated form; in Cuvier's specimen the ascending apophysis was flatter, broader, and directed toward the calcaneal facet instead of from it; it lacked the submedian perforation. Its tibial face appears to have been rounded, not angulate. The tibia presented an ascending ridge, to the face of which the ascending apophysis was applied; in the Laelaps aquilunguis there is no ridge, the apophyses reposing in a slight concavity. This apophysis, like the slender portion of the fibula, is composed of dense bone.

Cuvier describes at the same time a bone, of which he says "il ne serait pas impossible que l'os (fig. 39) fut la tete supérieur du péroné du pied que je viens de decrire." This piece has a shaft compressed at right angles to the direction of its head, a form so unlike the fibulæ of known Dinosauria, including Megalosaurus and Laelaps, as to render such a relation to the before-mentioned tibia, very doubtful. It is probably a metatarsus.

The second example of the clasping astragalus with anteriorly directed condyle is the Poecilopleurum of Deslongchamps. Here the angle between tibia and metatarsus has been even greater than in Laelaps. The ascending anterior ala is broader than in Laelaps, and appears to be complete and not continuous above with the fibula. That it is in contact with the fibula he states thus: "its internal face is applied to the tibia, while its external was without doubt covered in part by the inferior extremity of the fibula." This, with identity of form between the extremities of the fibula, and of the ascending process of the astragalus, in Laelaps, renders it probable that the relation is similar in the latter. I may add that I suspect that Deslongchamps like others has reversed the relations of the extremities of the fibula. If both the extremities figured by this author belong to it, it is much less attenuated than in Laelaps.

The tibiae figure by Cuvier and Deslongchamps appear to belong to different species. They differ in many respects as figured. The former has a more contracted shaft than the other; its extremity is less oblique; the inferior plate of the astragalus thicker and less produced; the anterior plate in every way smaller. The species should be called Poecilopleurum gallicum. (*Laelaps gallicus m.* Pro. Ac. N. Sci., Phil., 1867, 235.)

* See Gegenbaur, Carpus and Tarsus; tarsus of Chick ninth day, Tab.

The direction of the condyle in these genera indicates the articulation of the distal tarsal and metatarsal elements to have been at a considerable angle with the shank of the leg, and that the direction of the whole foot was oblique as in the birds. As the type is in respect to this articulation between that of Iguanodon and that of Compsognathus, we may probably attribute to it a length of metatarsus intermediate between those possessed by these two, a proposition confirmed by the metatarsals of an allied species, L. macropus m, preserved in the Museum of Rutger's College, New Brunswick, and described by Leidy. These are double the length of the slender phalanges and near one-half that of the tibia, slender and pneumatic.

Among the remaining Dinosauria the two rows of tarsals are distinct and composed of several elements; one of the proximal series articulating with the largely developed fibula as in the Sauria proper. For this I have proposed the name Orthopoda as the tarsal and metatarsal elements do not seem to have been capable of the same degree of flexure on each other as in the Goniopoda and Symphypoda.

Phalanges.—No. 1. An ungual phalange of remarkable size and destructive use. The depth at the proximal articulation is about the same as in Megalosaurus bucklandii (two inches without inferior tuberosity), but the length is considerably greater. Form everywhere compressed, especially at tip; rounded above. Below the articulating surfaces is the point of insertion of a large flexor tendon, a flattened subglobular process, separated by a groove except in front. The groove extends on each side distally on the middle, to the tip. The general form is not unlike that of a rapacious bird, but it is more compressed.

	Inches.
Length on convexity,	$9\frac{3}{8}$
Chord from articulatory surface,	$6\frac{1}{4}$

Surface slightly striated at the base on one side.

No. 2. Penultimate. Proximally higher than broad, distally broader than high; two elevated articular surfaces proximally, distal condyles separated by a deep groove and much prolonged inferiority; a fossa on each side eccentric to the condyle. Superior outline straight, inferior descending behind.

No. 3. Also penultimate, is flatter and more parallelogrammic in section than the last.

No. 4. Antepenult? more cylindrical, condyles broken.

	Inches.
Length, No. 2,	4.75
Proximal elevation,	1.75
" breadth below,	1.75
Breadth shank below,	1.25
Distal width,	1.25
" " of condyles below,	1.75
No. 3, proximal breadth below,	2.125
Breadth shank below,	1.50
Terminal and inferior breadth distal condyles,	1.875
No. 4, length,	6.

Another phalange of a much larger individual pertaining perhaps to Laelaps, which was accompanied by a plate-like bone, is thus described in the Proceedings Academy Natural Sciences, 1866, p. 6:

"Dr. Leidy directed the attention of the members to the specimen of a large phalanx of an extinct reptile, presented this evening by Dr. W. Spillman of Columbus, Miss. It was derived from the cretaceous formation in the vicinity of the latter place, and is remarkably well preserved. It is a first phalanx, and in general form resembles the corresponding phalanges of the Alligator, but is proportionately more robust. The proximal articular surface is moderately concave, somewhat uneven; and in outline is transerve oval with the lower side flat; the distal extremity is provided with a trochlear articular surface and deep pits literally for ligamentous attachment. The animal to which the bone belonged is unknown; it may be conjectured to have appertained to the fore foot of Hadrosaurus. The measurements are as follows:

	In.	Lin.
Length in the axis,	5	8
" laterally "	6	
Transverse diameter of proximal end,	2	11
Vertical " " "	2	5
Transverse diameter of distal end inferiorly,	2	$5\frac{1}{2}$
Vertical diameter at middle of trochlea,	1	6"

The phalanges and tibia figured by Leidy in Cretaceous Reptiles, tab. xvii., 8–11, differ from those from Barnesboro, and, I suspect, belong to another species. Indeed these portions are so uncharacteristic in Reptiles that they cannot be certainly assigned to the genus Laelaps.

Whole Hind Limb.—The femur and tibia together measure 65.50 inches. A method of estimating the length of the metatarsus is by comparison with that of Hylaeosaurus, as described by Prof. Owen. The distal extremity of the inner metatarsus in L. macropus (fig. 13) is much like the same in Hylaeosaurus, while the proximal of the outer is like that of Megalosaurus as figured by Owen, so that I estimate their length together to have been ten inches. The transverse extent of the tibia in the same species is four inches. The latter measurement in L. aquilunquis being seven inches, it gives as the whole length of the metatarsus eighteen inches.

The length of the tarsal region may have been five inches.

The longest digit most probably embraced as in the crocodile, four phalanges. None of the eight phalanges of the genus which have been preserved are of shortened form like the penultimates in the Palapteryx etc., but though from different portions of the toes are all well represented by those of the crocodile. I am disposed therefore to believe that the toes were long, and to attribute to the longest a length of twenty-one inches, measuring the chord of the ungual phalange.

These measurements give for the total length of the extended hind limb, ten inches more than eight feet. This is probably greater in comparison with the total length than in Hadrosaurus, where the elements beyond the tibia are comparatively short. The length of the hind limb in Hadrosaurus foulkii was probably a little over nine feet.

Pubes.—Each pubis has a gentle sigmoid flexure and a subtrigonal section. They are flattened at the inner extremity, and dilated, with a margin at right angles to the shaft; the whole of this extremity is not preserved. It is hollow, while the shaft is dense and heavy. Length 18.5 inches. I am disposed to regard these slender bones as pubes also, because they are homologous with similar bones in Hadrosaurus, whose ischia we are probably in possession of, which are quite different. Moreover the pubes of Hadrosaurus would not support the animal's weight as ischia, nor would they permit any lateral motion of the caudal column. The tail of Laelaps probably possessed such a motion, and if the ilium be similar to that assigned to Megalosaurus by Huxley, the long pubes if placed in the position of ischia would interfere with such motion.

The elongate ischia of Stenopelix are not dissimilar to those of Laelaps, but in the more nearly allied Compsognathus the pubes are the more elongate.

? *Ilium.*—Huxley's statement that the so-called coracoid of Megalosaurus is the ilium, leads us to anticipate a similar form for that of Laelaps. In Megalosaurus it is a semidiscoid plate, the superior margin forming an arc, the inferior furnishing the acetabular and articular surfaces. It has not the elongation of that of the Orthopoda, but is thinner and lighter.

? *Sternum.*—Very broad, thin, plate like bones have been on three occasions found with Goniopod Dinosauria. One of these was found with the New Jersey, the other with the Mississippi Laelaps. The Mississippi specimen is 13.5 inches long, and presents a thickened margin with convex outline on one side, and thins away to a thin edge at a width of 4 in. 5 lin. One side of this plate is convex, the other concave, and the ossification radiates from the middle of the thickened margin in every direction. There are no traces of contact with diapophyses of a sacrum. The New Jersey specimen, found with the other remains of Laelaps aquilunquis, is merely a piece broken from the thickened margin of a similar, though smaller bone measuring some 4.5 in length and 1.75 in width.

The form of these pieces reminds one of the thin concave anterior expansion of the ilium in gallinaceous and other birds, or if sternal, of the xiphisternal element.

External Form and Posture of Laelaps.—The short fore limbs of this genus suggest at once the habit of using the hind limbs chiefly, yet this disproportion is no sufficient reason therefor, and is seen to exist in the tailless Batrachia, where no such position is assumed. It exists to a less degree among the modern lizards, whose position we well know to be always horizontal.

Laelaps had, however, no doubt an erect position for the following reason: The head and neck of the femur are at right angles to the direction of motion on the condyles, or in the same plane as the transverse direction of the condyles. This indicates that the femur has been flexed, and extended in a plane parallel with that of the vertebral column. The relations of articulation are those of birds and different from those of reptiles, where the directions of the proximal and distal condyles of the femur are oblique to each other, and the proximal, of vertically elongate form, thus allowing the femur to be obliquely directed as regards the axis of the body, so that in a prone position it rested on the ground equally clear of the body and the flexed tibia.

The resemblance of the tibia with its high crest and embracing astragalus, as well as the slender fibula, to those of the birds, confirms this position; so do types of the iliac and sacral structures. The same is suggested by the great bird-like reptile tracks found in many places.

How must a reptilian form with elongate vertebral column and heavy tooth-bearing cranium have stood erect? The elongate form of the femur, as compared with the tibia, is only seen in man, who walks erect; in the birds and kangaroos the femur is very much shorter than the tibia; besides these, no other vertebrates walk on the hind limbs, entirely or in part. The lizards, which are prone, present the long femur exceeding or equalling the tibia.

The bird-like reptile did not, however, exhibit the slight flexure between femur and tibia presented by man. The acetabulum in the known Dinosauria is not or but weakly completed below, or what would be in man anteriorly, indicating that the weight of the body was supported by a femur placed at a strong angle with the longitudinal axis of the ilium; otherwise the head of the femur would be most readily displaced. If, therefore, the ilium were more or less erect, the femur was directed forwards; if horizontal, the femur must have projected downwards. I have shown, however, that the position and therefore the ilium was oblique or erect; therefore the femur was directed very much forwards.*

* The remarks of Prof. Owen on this relation in Megalosaurus are so pertinent, that they are introduced here:

"The backward position and production of the corresponding articular prominences or condyles in both femur and tibia indicate that these bones were joined together at an angle, probably a right one when in their intermediate state, between flexion and extension; and that the motion of the tibia could not have taken place to the extent required to bring the two bones to the same line."

There are, however, other reasons for believing that the femur was directed forwards, and somewhat upwards from the ilium. One is, that the centre of gravity of an elongate reptilian dorsal and sternal region must have been further forwards than in the short-bodied bird, and therefore the knee must have been further forward, in order to bring the support, *i. e.*, the tibia, etc., beneath it. Another is, that the articulation of the tarso-metatarsal bones with the tibia is excessively oblique, requiring that one or both sections of the limb should be very oblique to the vertical line. As the tarso-metatarsal elements support the weight immediately on the ground, and as it is obvious that the leverage moving the great weight of the body on its support must have been the gastrocnemius and soleus muscles extending the tibia on the metatarsal segment as the fixed point; and as there is no indication of correspondingly powerful muscles to flex the metatarsals on the phalanges; it is obvious that the latter has been the more vertical, and the former the more oblique segment. And if the tibial segment has been oblique, for reasons just given, the femur must have been oblique also.*

The length of the femur has had relation to another peculiarity as well, as follows:

In an animal designed to walk erect, it is necessary that the centre of gravity should be transferred as far posteriorly as is consistent with the type. In Laelaps and other Dinosauria we have very elongate pubic and iliac bones, and as I have before described, these appear to have been designed to enclose and support an abdominal mass, in a position beneath the sacrum, and posterior to the position observed in quadrupedal mammals and reptiles. We would thus have a prominent keeled belly between the femora, supported by elongate curved ischia behind, and slender pubes directed downwards in front. In Poecilopleurum the space between the latter and the sternum was occupied by abdominal ribs. The length of femur places the arc through which the knee moves beyond this projection.

The confluence of a greater number of vertebræ to form a sacrum seen in this order and in the birds, would seem to have a direct relation to the support of the above mentioned greater weight by it, than in horizontal vertebrata, where the weight is distributed throughout the length of the vertebral column.

The shifting of the neural arches backwards, seen in the same orders, pointed out by Owen, would have a mechanical relation to the same necessity; *i. e.*, their partial transfer over the intervertebral spaces naturally tending to strengthen the union of the sacral elements.

The foot need not however have been placed precisely beneath the centre of gravity of

* Probably in a squatting posture the animal rested on the entire sole as far as the heel, though not under ordinary circumstances; as I have suggested in Amer. Naturalist, I., 28, Mycteria and other wading birds assume a similar position at times.

the body, as the animal was furnished with a tail of greater or less weight. This member bears however little proportion to the great size of those seen in Iguanodon, Hadrosaurus, etc., but exhibits a commencement of the reduction which is so striking among the birds.

The proportions of the metatarsus are only to be ascertained by an examination of those of allied species, as L. macropus and Megalosaurus bucklandii. As all the other bones are more slender than those of the latter, so were no doubt these bones longer in proportion to their breadth. I have estimated it above, as equal to a little over half the tibia.

The digits in the genus Laelaps have not in all probability, been more than three. The less bird-like forms of Hylaeosaurus and Iguanodon, have had according to Owen, but three metatarsals, and it is not according to the *rule of successional relation*, that there should be any repetition of a reptilian character, in a point of prime importance in measuring the steps of succession between reptiles and birds. Laelaps and probably Megalosaurus, also, had but three digits directed anteriorly, and a fourth rudimental.

It is true that Deslongchamps ascribes five digits to Poecilopleurum after a careful study of abundant material. He was however much more impressed with the crocodilian affinities of that reptile than with any other, and did not recognize the avine in the astragalus. It seems to me quite possible that one of his toes can be dispensed with, for example the second, of which but one phalange is said to remain. If we ascribe the fractured extremity of the bone regarded (Tab. VIII., p. 6,) as the first phalange of the fourth digit, to the metatarsal of the same, the phalange referred to the second may find another place. The fifth digit also rests on the evidence of one phalange only. Though the reasoning of Deslongchamps in referring these pieces is good, it seems to me that renewed study might result in ascribing to his genus, three toes anteriorly and one appendicular, his first.

The predominance of reptilian characters in the Dinosauria as indicated by the structure of the vertebræ, and other points, renders it probable that the vertebral column did not present that remarkable flexure where the cervical and dorsal series are joined, which is seen in the birds, but rather that they were more or less continuous, and formed a continuum from the sacrum to the nape. The cervicals may have been somewhat elongated as in some birds, yet this is not probable in view of the necessary balance to be preserved, which would not admit of much projection of the cranium anteriorly. The cervicals of Hadrosaurus are not so long as in the modern Varani; in Iguanodon they are similar, while their rather oblique articular faces indicate the elevation of that region, and of the position of the cranium. In the case of these animals, there is not the same necessity for a long neck as in the birds, for even in Laelaps and other genera which probably never used the fore limbs in progression, they furnished a support to the body when the head was employed in taking food, etc., in the ground.

The caudal region affects the general proportions of a vertebrated animal materially.

In Laelaps it is shorter than in any known Dinosaur, measuring less than the hind limb by a foot. It was cylindrical, slender towards the tip, and in fact not unlike that of a dog, and probably capable of motion similar to the latter. When the Laelaps stood erect, the tail would trail its extremity on the ground, but could furnish little support.

Comparison with other Dinosauria.—The species with which detailed comparison can be made, are the Poecilopleurum bucklandii Deslongchamps, and Megalosaurus bucklandii Mantell. All three were of nearly similar size. The Poecilopleurum is better known than the Megalosaurus, and furnishes many similar parts. Thus the humeri possess the the same disproportionately small size, the extremity of the tibia is similarly expanded and flattened, and is similarly embraced by the astragalus. There are, however, abundant specific differences in all the bones described by Deslongchamps. In the same manner the Laelaps aquilunguis presents abundant specific difference from the Megalosaurus bucklandii. The slender, curved femur differs from the massive straight one of the latter; the tibia is more slender, and more flattened distally; its extremity is wedge-shaped, not rhombic as in European species. The claws of the Megalosaurus are relatively shorter and less curved.

The generic relations with these two types must be understood. Laelaps is obviously distinct from Paecilopleurum in the structure of its feet. In the former the phalanges are slender, in the latter massive, and mostly broad. The claws are more different; in the former compressed and hooked; as broad as deep in the latter, and but little curved. They are prehensile in the former, in the latter not at all, or adapted only for defense; they present a very small point of insertion, compared with the large knob of the former; they also exhibit a deep groove on the side, which is weak in Laelaps. The difference in this respect is about that between a raptorial and rasorial bird.

As compared with Megalosaurus, Laelaps probably had very short fore limbs. I have pointed out the difference in the femur, which is perhaps no more than specific, though this cannot be positively asserted. The difference in the form of the extremity of the tibia I suspect also to indicate more than specific difference. The bone supposed by Owen (Palaeontographical Society) to be scapula furnishes means of estimating the size of the humerus. The glenoid cavity is some six inches in diameter, indicating a humerus of four times the size of that of Laelaps at least. But this bone is more likely to be an ischium than scapula. The claws also of Megalosaurus are intermediate between those of Laelaps and Poecilopleurum, being less compressed and hooked than in the first.

Size.—In estimating the length of this reptile we have the lengths of the limbs and tail, and proportions of parts of the jaws to rely on. There is some reason to believe that the lengths of the hind leg and the tail were similar. In erect animals, as the Kangaroos and Ostrich, the length of the vertebral column anterior to the sacrum about equals the

length of the hind limb. In the present form the limb is increased by the greater length of the femur than in either, but is shorter than that of the bird by the abbreviation of the metatarsals. The proportions would then remain about the same as in the bird were it not that a larger head has evidently been borne upon the cervical vertebræ than in that class, and more as in the Kangaroo. It appears, then, that the increased length of the femur in Laelaps may be added to the proportions of the Kangaroo, thus giving a nearer equality between the lengths of the hind limb and the body and head together. The length would then be eighteen feet, divided as follows:

	Ft.	*In.*
Tail,	8	6
Body and neck,	6	10
Head,	2	
	—	—
	17 ft.	4 in.

This is probably the size of the Barnesboro individual, which is in all probability young, as the sacral vertebræ are entirely ununited. The phalange from Mississippi, above described, is very much larger than any of the former, and may have belonged to an adult animal. In any case it indicates a gigantic reptile of twenty-three feet or more in length.

The femur of the young individual is as long as that described by Owen (Palaeontographica) as belonging to Megalosaurus. As that genus was probably more bulky anteriorly than Laelaps, its length as compared with the dimensions of the hind limb is greater. If however it approached Laelaps in proportions as is probable, the length of thirty feet assigned to it, appears too great. In fact it can hardly have been larger than the Mississippi, or adult Laelaps a q u i l u n g u i s.

Thus the original estimate of the lengths of these carnivorous Dinosaurs is still further reduced. Owen accomplished part of this by estimating on the mammalian, and rejecting the reptilian type; the introduction of the avine element places the proportion at about the proper point in respect to the Goniopoda at least.

The elevation of the head of Laelaps would no doubt depend more upon the pleasure of the animal, than in a more quadrupedal form. Nine feet above the ground is a probable estimate for the young one, and twelve for the adult.

Movements.—The mind will picture to itself the actions and habits of such strange monsters as the Dinosauria, and in respect to some of the genera there is considerable basis for speculation.

That monsters walking on two posterior limbs have inhabited the earth has been

familiar to all since the publication by Hitchcock and Deane of the histories of the great foot tracks of the Triassic Red Sandstone of the Connecticut Valley. Such tracks have been discovered by John Smock in the same formation in New Jersey, and by Dr. Chas. Hitchcock in Pennsylvania. Prof. Hitchcock ascribed the tracks described by him to birds. Prof. Agassiz* expresses the belief that they were made by vertebrates combining characters of existing classes, perhaps of Reptiles and Mammals, rather than by birds. Now a carnivorous Dinosaur probably allied to Laelaps, as proven by a portion of the jaw with teeth, in the Academy's Museum, the Bathygnathus borealis of Leidy, has left its remains in the red sandstone of Prince Edward's Island, of the same age, and we safely conclude that some of the large clawed biped tracks of Hitchcock resemble those of that animal. Dr. Leidy has suspected that this would prove to be the case, as he asks† "was this animal probably not one of the bipeds which made the so-called tracks in the sandstone of the Connecticut Valley?" This inquiry was after an examination of the form of Laelaps, answered in the affirmative. I have ascribed these tracks to Reptiles allied to Laelaps,‡ and Huxley believes also that they were made by Dinosauria.§

The creatures which strode along the flats of the Triassic estuary have been various in species and genera, as pointed out by Hitchcock. Some were purely biped; some occasionally supported themselves on a pair of reduced fore limbs. There are impressions where these creatures have squatted on their haunches. One can well imagine the singular effect which these huge gregarious reptiles would produce standing motionless, or marching or wading slowly along the water's edge, ready for a plunge at passing fishes or swimming reptiles. But in the active pursuit of terrestrial prey did such an animal as the Laelaps run like the Ostrich, or leap like the Kangaroo. So far as the triassic tracks go, there is little evidence of leapers, chiefly runners, fell upon an exhausted quarry. Or were they only carrion eaters, tearing and devouring the dead of age and disease? Probably some were such, but the prehensile claws of Laelaps are like instruments for holding living prey.

Laelaps has a long femur; those great leapers the Kangaroos have a short one; the cursorial birds, however, have a similarly short femur, but they do not leap. So this form is not conclusive. The modern Iguanas have a long femur, and they all progress by their simultaneous motion; they only leap; but man with his long femur runs only. The question, then, does not depend on the form of the femur.

I have suggested, on a former occasion, that Laelaps took enormous leaps, and struck its prey with its hind limbs. I say, in describing it, "the small size of the fore limbs

* Contrib. Nat. Hist. U. S., 1857, Vol. I. † Jour. Ac. Nat. Sciences, 1854, 323.

‡ American Naturalist, 1867, 27. Hays' Medical News and Reporter, 1868.

§ Proceedings Royal Society, London, 1868. Natural Science Review, 1868.

must have rendered them far less efficient as weapons than the hind feet, in an attack on such a creature as Hadrosaurus; hence perhaps the latter were preferred in inflicting fatal wounds. The ornithic type of sacrum elucidated by Prof. Owen, suggests a resemblance in the use of the limb."

There were but few animals then living which could afford long pursuit on land, so far as known, excepting among the Dinosauria of that day. The Laelaps had to contend with hard-shelled turtles or armored crocodiles, or the swift sea-saurians. These it must capture by sudden movements, as it is not likely that its grasping toes furnished much natatory power.

The lightness and hollowness of the bones of the *Laelaps* arrest the attention. This is especially true of the long bones of the hind limbs; those of the fore limbs have a less considerable medullary cavity. In this respect they are quite similar to those of Coelosaurus Leidy, of which its describer remarks that "the medullary cavity of the tibia is large, and the walls thin and dense," "being intermediate in this respect between the characters of the Mammals and Birds."

The mutual flexure, as well as the lightness and strength of the great femur and tibia are altogether appropriate to great powers of leaping. The feet must have been elongate, whatever the form of the tarsi; the phalanges, or toe bones were slender, nearly as much so relatively as those of an eagle, while the great claws in which they terminated were relatively larger and more compressed than in the birds of prey. There was no provision for the retractibility observed in the great carnivorous mammalia, but the size of the inferior basal tuberosity indicates the insertion of a great tendon of a powerful flexor muscle. The slight grooves at the base, and deeper one on each side of the phalange, indicate the usual horny sheath, which, prolonging the point of the claw, would give it a total length of ten inches.

The tail was moderately long, rounded and strong, and not so much a support as capable of striking a blow and of throwing an enemy within reach of the kick or grab of the terrible hind leg.

The fore limbs must indeed have been of very little use, and it is very difficult to imagine an animal both running and seizing the prey it overtakes, with the hind limb. If it were not a carrion feeder it must have leaped. We are informed by Hochstetter* that the Apteryx leaps with the utmost ease over objects two and three feet in height, that is, higher than its head. Huxley suggests that the Compsognathus "hopped" along on its hind limbs. The bulk of Laelaps is no objection to its leaping, for the giant extinct kangaroos, Macropus atlas and titan, found in the postpliocene caves of Australia, did not fall far short of these reptiles, in this respect. We may add that Laelaps had smaller allies, as

* New Zealand Amer. Trans., 181.

L. macropus one-half, and Coelosaurus antiquus one fourth or fifth the size, whose remains so far as they go indicate an identity of habit. Deslongchamps says of Poecilopleurum bucklandii that it "could project itself with prodigious force, as a spring which unbends itself; but this could not have been on a solid surface, since the fore limbs are too weak to resist the shock of the fall of such a heavy body." He supposed it to be marine in its habits, accustomed to battling a stormy sea. However his objection to leaping on land is obviated by our hypothesis of its erect attitude, and its exclusive use of the hinder limbs, the weight always falling on the latter.

The disproportion between the fore and hind limbs of the Iguanodon, together with the compressed form of the tail suggested to Prof. Owen an aquatic habit, a relation of proportions of limbs to habit seen in the tailless Batrachia. The discovery of the massive short-toed foot of the Iguanodon subsequently, has lent little countenance to the supposition of its entire adaptation to aquatic life. Dr. Leidy has regarded the still greater disproportion in the case of the Hadrosaurus as an index of a habit like that of the Kangaroos (Macropus, etc.), and that that moster rested in an oblique position on the hind limbs and tail, and reached upwards with its muzzle and short fore limbs to the foilage on which it fed. He seems also to have regarded it as aquatic as he adds, "on the shores of the ocean in which it lived." These genera could not have been aquatic in any great degree, as the form of the toes was too stout, and they could have been too little separated to allow of a natatory web.

The bulk of the species, as compared with that of Hadrosaurus, illustrates again the law observed in the relation between Felis and Bos, and the other raptorial and herbivorous Dinosauria.

In the same chocolate greensand bed the workmen found a femur of Hadrosaurus foulkii, smaller than that described by Dr. Leidy; also portions of Mosasaurus dekayi. Either on the chocolate or in the green stratum above it, remains of Bottosaurus harlani, Hyposaurus rogersi Owen, and Holops gavials of perhaps four species, with Cimoliasaurus magnus Leidy, were found.

The only molluscs which occurred with the remains of Laelaps were Baculites ovatus and Cucullaea vulgaris. Ten feet above is a stratum of Ostrea vesicularis and Terebratula harlani.

Synonymy.—The only doubt as to the proper name of this genus, has arisen with reference to the description of the genus *Dinodon* by Leidy. I have cleared this matter up in Silliman's Journal, 1868, p. 415, as follows:

In the Transactions of the American Philosophical Society, xi. p. 143, Dr. Leidy describes a large, carnivorous reptile allied to Megalosaurus, under the name of *Dinodon horridus*. He assigns to it, with some expression of doubt, teeth of two distinct forms, viz: some having a lenticular transverse section, with crenation on the two margins in part, and others having a lenticular section truncate to a greater or less degree, in place of one of its angles, and therefore crenate on three edges in part.

If Dr. Leidy had left the matter undecided as to which of these he regarded as the type of the genus *Dinodon*, the almost universal practice of naturalists would refer the name to that form which should not be first thereafter discovered to be distinct, and named.

I have been of the opinion that the two forms of teeth included by Leidy under the head of Dinodon really belong to distinct animals, and Leidy is also of that opinion. In 1866, in describing the genus Laelaps (Proc. Acad., p. 279), I said, "The genus Laelaps belongs to the family Dinodontidae which is characterized, * * by its compressed, sabre-shaped teeth. It differs * * from Dinodon in that teeth of the latter have two posterior serrate edges separated by a posterior plane." This, then, according to the usage of naturalists establishes the name Dinodon for the truncate teeth and Laelaps for the two-edged.

Dr. Leidy however in an essay published in Proc. Academy Nat. Sci., 1868, p. 198, in expressing his belief in the distinctness of the two genera, states that "teeth of like shape" (*i. e.* like Megalosaurus) referred by me to Dinodon alone belong to this genus, and names the species represented by the truncate teeth, or the true Dinodon horridus, *Aublysodon mirandus*. He then goes on to say, "Future discovery may prove Laelaps and Dinodon identical," and on p. 199 * * "An enemy which may perhaps on nearer comparison of corresponding parts prove to be another species of the same genus until now supposed to be different, under the names of Dinodon and Laelaps." It is thus sufficiently obvious that the proposition is to refer Laelaps as a synonyme of Dinodon. It appears to me, on the other hand, that this is contrary to the rules of nomenclature, and the principles which lie at their root, and that the name *Aublysodon* is a synonyme of Dinodon.

This is however on the supposition that Leidy had left the question open or uncertain, as to which of the two forms of teeth was characteristic of his genus Dinodon. I think however he has not left it undecided, and I am supported in this by the opinion of Von Meyer.

The teeth of Laelaps both from New Jersey and Nebraska do not differ from those of Megalosaurus, while those of Dinodon do. It was not to be supposed that Dinodon was established on teeth of the former character, as the practice of describing species and genera, without a basis of distinctive characters is an unusual and bad one, and ought not to be tolerated in natural science.

In describing Dinodon, Leidy says the Laelaps-like teeth resemble those of Megalosaurus, and in his recent article in the Proc. Academy (p. 198), that they are "identical in character with those of Megalosaurus."

He moreover specifies that the truncate teeth of Dinodon are really those that characterize it, in the following words: "as the entire dentition of Megalosaurus has not yet been ascertained, it may turn out to be the case that in other parts of the jaws than those known, it possesses teeth like the ones *above described as peculiar*. Should on future discovery such a condition of things be proved to exist, *Dinodon* would then cease to be anything more than a second species of Megalosaurus." The truncate teeth are then the "peculiar" feature of Dinodon, and all that prevents the species from being referred to Megalosaurus.

Von Meyer has understood this language as I have, and has believed that the teeth now ascribed by Leidy to *Aublysodon* are really characteristic of Dinodon. He says (Palæontographica, vii. p. 267) that some of the teeth "indicate such peculiarity, that Leidy, who has made the investigation, thought it necessary to characterize the animal as distinct from Megalosaurus, under the name of Dinodon h o r r i d u s.

It is therefore evident that the Laelaps-like teeth described under Dinodon, are really those that require a new name, if any. I will not give them a name however, since there is no evidence that they differ from either Megalosaurus or Laelaps, though of course the probability is, that they belong to a species of the latter genus.

Although Aublysodon would thus be a synonyme of Dinodon, it is not an altogether useless name, since the latter was given years ago to a genus of serpents by Duméril and Bibron, and may therefore be suppressed.

The classification and characters here employed in treating of the Dinosauria, were embraced in the original essay included in the present one, which was read, and the contents communicated verbally, before the Academy of Natural Sciences in the spring of 1867.

This point is alluded to partly because the portion of the original essay on the Dinosauria has been in part anticipated by the publication of a lecture by Prof. T. H. Huxley before the Royal Society of Great Britain, bearing date February 7, 1868. The tenor and result of the studies of Prof. Huxley were the same that followed my own, and the details of his reasoning are thus published prior to mine. The position of the ischia and pubes in the Dinosauria,

I had already believed to be as herein explained, and as stated by Prof. Huxley, though I had not been able, as he has, to place the elements called by Owen clavicles in the position of ischia, but rather of pubes. Prof. Huxley's determination of the ilium of Megalosaurus, a point of the greatest importance, was new to me, and I have added this and other allusions to his address. Other than these I have added nothing to the history of Laelaps since its original preparation beyond a few points in the restoration which grew only out of my original observations.*

It is not however a matter of surprise, that with the increased number of students at the present time, the same subject should be under cotemporary investigation, and the same results be brought out at the same time.

LAELAPS MACROPUS, *Cope.*

Coelosaurus antiquus, Part, Leidy Cretaceous reptiles, p. 119 (Fragments of tibia, metatarsal bone and phalanges from Monmouth county, N. J.) also p. 101. *Laelaps aquilunguis*, part, Cope, Proc. A. N. Sci., Phil., 1866, 279.

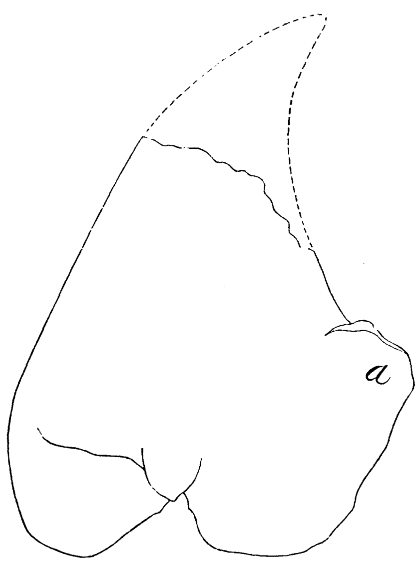
The remains on which this species is based have been described by Leidy l. c. without distinct determination. That it is distinct from the animal called by him Coelosaurus antiquus is very probable from the great difference in size (it is double the latter in most measurements), and from the greater expansion of the distal end of the tibia. Width head to tibia, 3 in. to 4 in.; in Coelosaurus antiquus 25 lin. to 31 lin. However, until some additional portions of Coelosaurus are discovered, its character will remain unknown, and I prefer to associate the present with Laelaps until this is the case. The event may be that it pertains to neither genus.

It differs from Laelaps aquilunguis in its much smaller size (if adult) and in the relatively larger size of its phalanges, and consequently larger feet. Compare the transverse width of the distal end of the tibia and length of a penultimate phalange in each.

	Tibia.	*Phalange. P. c.*
Laelaps aquilunguis,	7 in.	4.75 = .67
Laelaps macropus,	4 in.	3.5 = .87

The proximal phalanges differ also in their greater depth proximally, and in that their inferior tubercle is expanded throughout the whole width of that extremity. The head of the tibia bears on its exterior outline a tuberosity not seen in L. aquilunguis (*a* in the outline, fig. 31).

Fig. 31.



A fragment of metatarsal is described by Leidy, and the distal extremity figured. It appears to have been the external one, and its condyle is directed slightly outwards. It is flattened on the inner face, indicating close contact with its fellow. The proximal portion of another appears to be the external of the other side. It is also flattened on the inner face, by an oblique plane which looks upwards and inwards, and which narrows distally. Proximally it widens as the face of a transverse dilatation of the extremity, which gives the articular end a V shape. See fig. 32a (nat. size). To this is added a infero-superior view of the same extremity one-half nat. size, and fig. 33, an extero-posterior, and fig. 34 an extero-anterior view of the distal extremity of the other.

* See Hays' Medical Journal, Philada., March, 1868.

Fig. 32.

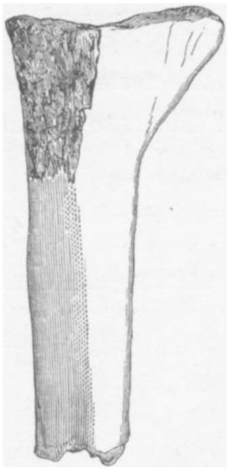


Fig. 32a.

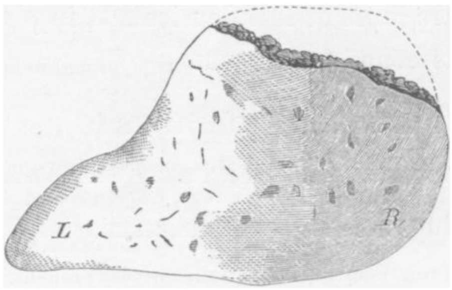


Fig. 33.

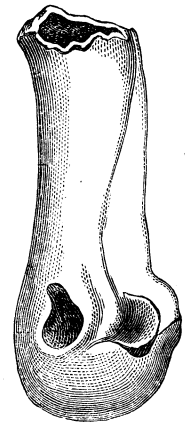
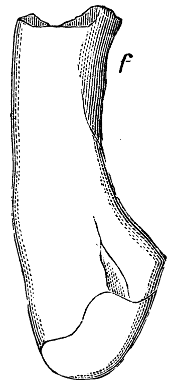


Fig. 34.



These indicate a more or less elongate metatarsal region and elevation of the heel above the ground.

Upper cretaceous, upper green sand bed Monmouth Co., N. J.

COELOSAURUS, *Leidy*.

Another bird-like type of dinosaur, like Laelaps. The only species known is of more slender build and smaller size than the latter. The hollowness of its bones, etc., indicate its powers as a runner or leaper. But few remains of the genus have been procured. It is known only from one tibia. From this slight indication the degree of difference in general structure is not readily attainable. The tibia is in all its proportions more slender, and presents a higher crest; its distal articular surface is more transverse to its longitudinal axis. The species C. antiquus has been much smaller, and more lightly built; the tibia is about one-fifth the size of that of L. aquilunguis.

COELOSAURUS ANTIQUUS, *Leidy*.

Cret. Rept. p. 119 (name) & 100. Tab. III, f. 1, 1865.

Cretaceous green sand of New Jersey.

BATHYGNATHUS, *Leidy*.

BATHYGNATHUS BOREALIS, *Leidy*.

Leidy, Journ. Ac. Nat. Sci., Phila., 1854, p. 327, Tab. xxxiii.

Known only from a portion of mandibular ramus with teeth. Probably one of the types whose tracks are preserved in the red sandstones of the Connecticut Valley. Though placed among the Thecodonts by Owen, I greatly suspect that its true place is here. Triassic red sandstone of Prince Edward's Island, New Brunswick.

AUBLYSODON, *Leidy*.

Dinodon, Leidy (not of Duméril & Bibron) Proc. Ac. N. Sci., Phila., 1857. *Aublysodon*, Leidy, l. c. 1868.

This genus differs in its dentition from Laelaps and Megalosaurus; the teeth present a posterior plane whose margins are more or less denticulate, in place of the acute crenate margin of the former. None of its bones are known.

AUBLYSODON HORRIDUS.

A. mirandus, Leidy l. c. 1868, 298. *Dinodon horridus*, Leidy, Trans. Amer. Philos. Soc., xi. 1860, p. 140, Tab.

Upper Jurassic Bad lands of the Judith River, Nebraska.

TROÖDON, *Leidy*.†

TROÖDON FORMOSUS, *Leidy*.

Trans. Amer. Phil. Soc., 1860, 147.

Upper Jurassic bad lands of Judith River, Nebraska.

SYMPHYPODA.

First series of tarsal bones confluent with each other, and with the tibia.* Fibula distally much reduced. Anterior part of ilium dilated, plate-like.

Genera Ornithotarsus, Cope. Compsognathus; Wagner Abhandl. Mathem. Nat. Classe München Bd. IX.

The latter, says Gegenbaur, is the form among terrestrial Saurians nearest the birds, as Archaeopteryx is the avine type nearest the Saurians. From the upper Jurassic slates of Solenhofen. I add a few of its characters from Wagner.

Inner toe represented by a rudimental metatarsus. Whole foot a little larger than femur; humerus one-half femur. Of the only known species, C. gracilis, Wagner gives the following measurements: Length of head, 2″ 6‴ (French); of vertical column to opposite acetabulum, 10″; of anterior extremity, 4″ 7‴; of posterior, 9″ 3‴.

ORNITHOTARSUS, *Cope*.

Dr. Samuel Lockwood of Keyport, Monmouth county, New Jersey, discovered in a clay bank on the shore of Raritan Bay, a remarkable fragment of a gigantic Dinosaur.

* As first pointed out by Prof. Gegenbaur, Beitr. z. Vergleich Anatomie Wirbelthiere; Carpus U. Tarsus. 186 .

† The following genus and species may belong among the Goniopoda. Leidy includes it among his cretaceous Reptilia, but adds that it may be a fish.

DIPLOTOMODON, *Leidy*.

Tomodon, Leidy, not of Duméril and Bibron. Proceedings A. N. Sci., Phila., 1868, p.

Diplotomodon horrificus, Leidy, Cretaceous Reptiles, 102, Tab. Known from a single tooth.

Cretaceous green sand of New Jersey.

This gentleman observing that the gradual advance of the tide, owing to the slow depression of the coast line, was undermining a long bank of the cretaceous clay, carefully examined the debris, from time to time, and made the discovery of the fragment mentioned. No other portions rewarded his search, and as the bank has been gradually carried away since, there is little probability of the remainder being found.

The specimen consists of the extremity of the tibia with anchylosed astragalus, with part of the shaft and distal portion of the fibula adherent. From this the character of the genus may be derived, as follows:

Astragalus confluent with calcaneum, both together anchylosed to the tibia: articular face directed downwards and a little forwards. Fibula slender, articulating with the first tarsal bone. Medullary cavity of tibia small, occupied by a coarse cancellous tissue.

This genus confirms remarkably the propositions suggested by the remains of Laelaps, as to the probable continuity of the tarsal and tibial elements in certain of this order, and the relation of the fibula to the same. It proves that the latter bone has been reversed in the descriptions of Iguanodon and Hadrosaurus.

The suture connecting tibia and astragalus is distinct, so that I suspect that the latter is distinct from the former during a part at least of the early life of the animal. Thus there is the usual "parallelism" between the adult Orthopod and young Symphypod. There is an obliquity of the articular extremity to the axis of the tibia, indicating a prominence of the external tuberosity.

The fibula is subtrilateral, the posterior face being obtusely angular and fitting a slight groove, as in Hadrosaurus. The extremity presents an obtuse condyle inwards and downwards, which is applied to a corresponding concavity of the superior projecting face of the astragalo-calcaneum. The external angle is slightly prominent and angular.

The affinities of this genus are perhaps in some degree to Hadrosaurus; certainly nearer to it than to Laelaps. The inferior presentation of the ankle joint indicates short metatarsals, so that the form was probably heavy footed.

ORNITHOTARSUS IMMANIS, *Cope.*

Proceed. Amer. Philos. Sci., 1869, p. 117.

The accompanying cuts will give a good idea of the proportions of this fragment. The extremity of the tibia exhibits the anterior longitudinal concavity common to all the types of the order, and which as in them, is occupied by the ascending apophysis of the astragalus. The astragalo-calcaneum is a thin bone, and does not cover the extremity of the tibia internally and posteriorly. It thins out posteriorly and leaves a strong groove to mark the suture, apparently for ligamentous insertion. The transverse plane of the articular face is nearly even; and it is little contracted medially, much less than in Laelaps aquilunguis.

As compared with Hadrosaurus foulkii, which it most resembles, the extremity of the tibia presents many differences. First, the external face is much narrower, and more transverse, forming thus a less open angle with the posterior face. Second; the anterior concavity is less profound, giving the outline a more transverse direction.

The inferior outline in Hadrosaurus is an irregular inequilateral triangle, in this species an irregular parallelogram with one oblique extremity.

Fig. 35.

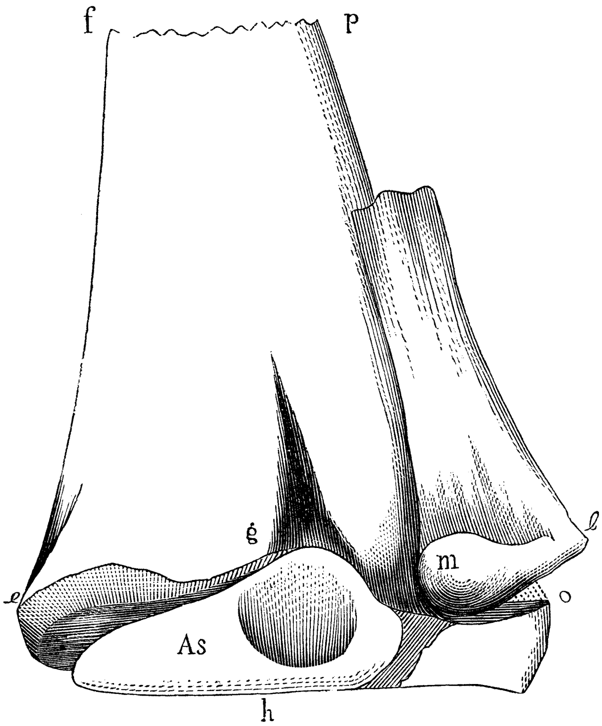


Fig. 36.

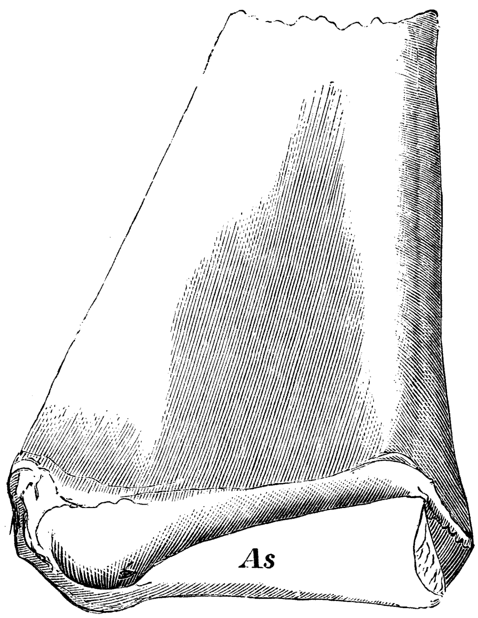


Fig .36a.

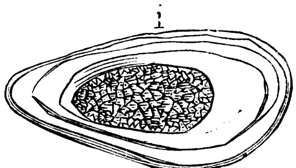
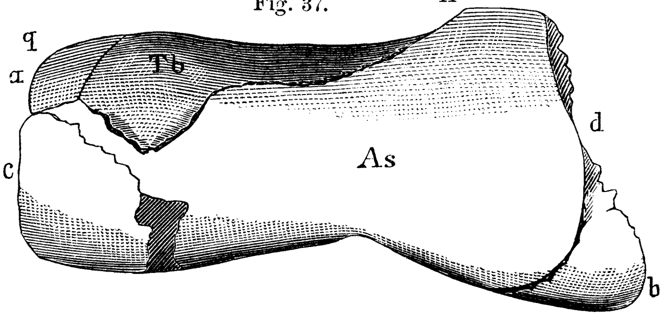


Fig. 37.



The measurements accompany the figures as follows:

	In.	*Lin.*
Length from *a—b*,	14	
" " *c—d*,	$12\frac{1}{4}$	
" " *e—f*,	14	
" " *g—h*,	4	
" " *i—k*,	3	7
" " *l—m*,	5	
" " *n—o*,	13	6
" " *f—p*,	5	9

These dimensions indicate one of the most colossal of the Dinosauria; and of which further information will be sought for with much interest. The length of the hind limb could not have been less than thirteen feet.

From the clays immediately below the lower green sand bed, in Monmouth county, N. J.

TRIASSIC DINOSAURIA.

CLEPSYSAURUS, *Lea.*

CLEPSYSAURUS PENNSYLVANICUS, *Lea.*

Journ. Ac. Nat. Science, Phila., II., 185, Tab. Emmons' N. Amer. Geol. p. 67 (in part).

This species is a Dinosaurian, as demonstrated by an ischium which I found among the original specimens, and which resembles in some degree that of Lælaps and Megadactylus. The genus appears to be closely allied to Palæosaurus. It was probably a "bird-track" maker. The remains from North Carolina referred to it by Emmons, belong in large part to a Belodont reptile.

Triassic Sandstones, Lehigh County, Pa.; Phœnixville, Pa.; Triassic Coal Measures, Chatham Co., N. Carolina.

MEGADACTYLUS, *Hitchcock.*

Supplement to the Ichnology of New England, p. 39, 1865.

This genus is indicated by remains in a more or less fragmentary condition, from the red sandstone rocks of the Valley of the Connecticut, from the neighborhood of Springfield, Massachusetts. They were found by William Smith, while engaged in superintending some excavations made at the armory, which required blasting.

The remains consist of four caudal, and one dorsal vertebræ, the greater part of the left fore foot with distal portions of ulnar and radius; the greater part of the left femur, proximal end of left tibia, greater part of left fibula, tarsus and hind foot, including a tarsal bone, perfect metatarsus, proximal end of a second metatarsus, parts of the distal end of a third, and parts and impressions of four phalanges. Also, the greater part of both ischia.

These fragments demonstrate the former existence in the region in question, of a form of the Dinosauria, not far removed in some points from the Palæosaurus of the English Trias. Its pertinence to the Symphypoda is suggested by the apparent absence of the calcaneum; but this is uncertain, for that element may have been lost. In Compsognathus the additional peculiarity of the persistence of but two carpal bones is presented, which, according to Gegenbaur, should correspond with those of the first row of ordinary Reptilia, while those of the second have disappeared. In Megadactylus those of the first series are present, viz: the radiale and probably ulnare, and one of the second row, very much reduced, opposite to the second metacarpus. There is space for a second one of the second series, but it does not appear in the matrix, while the ulnare is probably lost.

The bird-like tendencies of this type have been indicated above, and the very ornithic character of the bones of the present form is also very marked. The walls of the long bones are very thin, in some places near their extremities almost as much so as writing paper. The vertebræ and ischia present the same thin walls. The structure of these walls is exceedingly dense. The special characters are as follows:

Vertebrae. A dorso-lumbar is much compressed, but not keeled below; the articular extremities are expanded, and their faces slightly concave. An anterior caudal has a simi-

lar form, but the extremities are plane. The posterior basis of the neural arch is on the posterior third of the upper surface, and the anterior end has evidently supported its anterior part. They leave the median third of the canal open laterally, its median surface passing into the external over a lateral shoulder. The arch probably bridged over this interval. The chevron bone is long and wide, and with thin walls. A second caudal exhibits similar characters. Two adjacent caudals in the same piece of matrix exhibit shorter, deeper centra, with strongly concave inferior surfaces, which are separated from the laterals by an obtuse longitudinal angle. Articular faces concave, forming vertical ovals truncate below. The chevron bones are narrower, directed backwards, and of very light construction. The neurapophyses present the singular character indicated above. Their contact with the centrum is anterior and posterior only, their basis being excavated upwards into a regular arch, whose margins flare out a little. This remarkable structure is only paralleled in the sacrum of other Dinosauria, where the nerves destined for the sacral plexus, issue through huge foramina in the bases of the neurapophyses. Here the structure is continued on the caudals, and evidently for a very different purpose. The neural arch has a high longitudinal carina, which is continued in the neural spine. It is concave on each side between the zygapophyses. The posterior zygapophyses stand above an intervertebral space, and the narrow neural spine rises above them, as is usual in Dinosauria. The zygapophysial faces make about an angle of 45°. A distal caudal is slender, sub-cylindric, and with low neural arch.

The *right anterior foot* displays five digits, though one of them opposite the extremity of the ulna, was very short. The phalanges are, from without, ?—3—4—3—2; they are short and stout, the ungues short, deep, much curved and compressed. That of the interior digit is the largest; the inner edge is rounded, the superior broad and slightly flattened. At the middle of its length, a shallow groove near the dorsal outline begins to contract to a sharply defined, narrow groove, which continues to the end of the claw. The trochlear faces are well distinguished. The phalanges are stout and with a marked ligamentous pit on each side distally. The metacarpals of the two middle digits are slender and twice as long as the adjacent phalanges; that of the outer digit is one-third shorter, and that of the inner, one-half shorter than the median. The fourth metatarsus is longer than the external, but much more slender than any other. This finger was shorter than the third, and probably possessed three phalanges; portions of two are preserved, and the most distal is not ungual.

The extremity of the ulna larger than that of the radius and rather more expanded. Both bones of the fore arm are very pneumatic, and oval in section.

The *femur* is represented by both extremities with shaft adjacent, and that part of the shaft supporting the third trochanter. It is peculiar in presenting a combination of char-

acters. The proximal extremity resembles that of the Crocodilia, while the distal is truly Dinosaurian, approaching Megalosaurus. There is no distinct head, the whole extremity is compressed, and the extremital surface concave in its long axis. It overhangs the shaft on the inner side and forms a knob which is decurved, and contracts below abruptly to the shaft. The external margin is a subacute ridge; the small trochanter is represented by a short ridge which is but little defined on the inner side, and which sinks to the general level some distance below the head. The compression of the shaft changes to a sub-cylindric form, and just above this point the large third trochanter projects. It is short; inside of it a large rugose surface indicates the insertion of a powerful muscle. Near the distal extremity the shaft is compressed transversely. The articular face of the condyles is rather flat. The outer has the least posterior production, and has a continuous exterior face. The inner is divided exteriorly, near the posterior extremity, by a deep groove, which is continued obliquely forward and inward on the articular face. The anterior part of this condyle is strongly convex. The posterior is narrow and turned inwards and backwards to a sharp edge. This portion is outlined by the above mentioned groove, and forms a narrow ovate in section. The popliteal groove is quite deep, and the trochlear scarcely marked.

The *tibia* and *fibula* are broken. Of the first, a piece of the proximal portion alone remains; of the latter, a piece is broken from the middle of the shaft. The head of the tibia is flattened by pressure. The spine or crest is very prominent, but not so much so as in Lælaps, and is much curved outwards. The posterior angle of the proximal extremity is prominent, and the prominence to which the fibula is applied marks the anterior third of the long diameter of the head in its present condition. The anterior crest gradually sinks to the shaft. The greater part of the latter is flat, as an impression in the matrix indicates. The fibula is slender and oval in section, with very thin walls. At the distal extremity it expands slightly; the articular face is plane transversely, and moderately convex antero-posteriorly. Proximally the shaft expands in the direction opposite to its compression, giving the head a nearly equal extent in both directions. The articular surface is directed obliquely downwards to the tibia, and is more or less grooved; a strong rabbet extends round its posterior angle.

The *foot* is in relation to the extremity of the leg, in a strongly flexed position. The tarsal and metatarsal elements were somewhat separated by the strain, though in nearly normal position.

The *cuboid* bone alone remains of these. It is closely approximated to the fibula with a small interval occupied by matrix between. The form is somewhat like that in the genus Alligator, and it bears a similar relative size to the adjacent elements. It is a subtriangular piece with concave sides; the posterior angle, as it were, pinched. One lateral

face, probably anterior, presents a longitudinal groove; one broad face, perhaps the external, a convex articular surface. The metatarsal face is slightly concave.

The *metatarsus* which relates to the above, therefore the exterior, is much like that of the Alligator. The planes of the two extremities are nearly at right angles to each other. The proximal extremity is sub-triangular with an external angle prolonged, and the posterior outline longest and slightly sigmoid. The shank has a large medullary cavity; the distal articular surface is sub-truncate, and the ligamentous pit very shallow, indicating absence of much flexure at that point. The convex external face of the cuboid, indicates the existence of a rudimental external digit in the usual place of the fifth; it may have been but a part of a metatarsus, as in the crocodiles. No trace remains. Two other digits have left their remains. Of these the median is so much larger than those on each side of it, as to render it probable that this animal possessed but three developed toes; in those types with a larger number, the two median at least, are of proportions more nearly similar to each other.

One *phalange* of the middle toe is of a stout and somewhat compressed form. Two of the inner toe are more slender; the articular ligamentous pit is distinct in those of both and the condyle convex, indicating extensive flexure. All are hollow.

The disproportion between the lengths of the limbs is not readily ascertained; it is evidently not nearly so great as in the Lælaps, perhaps not greater than in many modern Lacertilia.

Ribs are represented by several fragments, one perhaps a half. They display both capitular and tubercular articulations, the former apparently much the more extensive. The head and shaft of the ribs are compressed, and the capitular prolongation is as deep as the base of the shaft. The latter has a groove along its dorsal line for the proximal two-fifths the length. It is hollow, the medullary cavity being equal in diameter to the wall surrounding it.

A Y-shaped bone with rather long stem has left an impression. The limbs of the figure are slightly unequal in length. Can it be a hatchet bone of the cervical vertebræ?

The pelvis is only represented by a considerable portion of both ossa ischii. These indicate a remarkable peculiarity of the type, and explain the structure in Lælaps and some other Dinosauria. The portions preserved are the distal and median, with the impressions of the more proximal in the matrix. The former consists of two stout rod-like elements, having a triangular section, the superior and inner faces being plane, the exterior convex. The two interior are in contact throughout the straight portion of the bones. The extremity is convex and enlarged, especially downwards, and the two are separated by a deep groove, giving a section of the extremity the form of an ∞. At the point of divergence the stylus is flattened, while the divergent portions are more flattened,

at first horizontally, then with a gradual approach to vertically. Like the other bones, they are pneumatic and thin walled proximally; at their medial portion they contain very light spongy cancelli.

As compared with Compsognathus the caudal vertebræ are very much shorter and deeper: the extremities are stouter and more robust; the metatarsi and phalanges with ungues being shorter and thicker.

That animals of this genus made some of the tracks similar to those of birds in the red sandstones of the Valley of the Connecticut, there can be no doubt. It furthermore explains some problematical impressions which are occasionally found with them. Tracks of an animal resting in a plantigrade position, as indicated by the moulds of two long parallel metatarsi, each terminated by three toes, are accompanied by a peculiar bilobate, transversely oval mark on the middle line, some distance behind the heels.

Prof. Hitchcock states that it appears to be the impression of a short stiff tail. The present specimen shows clearly that it was made by the obtuse extremities of the ischia. The saurian squatted down, resting on its styloid ischia as the third leg of a tripod of which the anterior pair was represented by the hinder legs. Prof. O. C. Marsh informs me that in the museum of Yale College, a slab exhibiting impressions similar to the above, shows the impressions of the anterior feet also, which were put to the ground in the act of rising or sitting, or perhaps reached to it, while the animal was squatting, as do those of carnivorous Mammalia.

The tracks of many of the animals discovered by Hitchcock are plantigrade. That they could not have walked like the plantigrade mammal, is sufficiently evident from the length of the metatarsal elements, which would necessitate a constant contraction of the tibialis anticus muscle, or peculiar arrangement of the tarsal bones, for its support. The latter does not appear to have existed, and the former is so very improbable, that, in connection with the pneumatic structure of the bones, there is abundant reason to suppose that they progressed by leaps, and assumed the plantigrade position when at rest.

No portion of the cranium or dentition of this genus has been preserved. The large stout hooked claws of the fore foot would indicate a more or less carnivorous diet.

The Connecticut Sandstones have been regarded as Triassic, which the lower portions of them undoubtedly are, and similar to the German Keuper in the presence of Labyrinthodonts, Thecodonts and Dinosauria in Massachusetts, Pennsylvania and North Carolina.

MEGADACTYLUS POLYZELUS, *Hitchcock.*

Loc. Cit. p. 39, 1865. Ichnology of Massachusetts, p. 186, 1858. Tab. IX, fig. 6 (Right fore foot).

This species was about the size of an ordinary hound. The surfaces of the vertebræ are smooth, and do not display any sculpture. Their dimensions are as follows:

	Lines.
Antero-posterior length median caudal,	10.1
Depth articular face,	11.4

	Lines.
Width articular face,	6.6
" lateral neurapophysial foramen,	6.8
Elevation neural arch at middle,	8.8
" " " and spine,	14.
Length proximal caudal,	13.2
Depth articular face do.,	12.2
Width neural canal,	3.2
" chevron bone,	3
Length " "	10
Width extremity of lumbar vertebræ,	8.

The femur has but little curvature; its narrow external outline is rather convex proximally.

Length of proximal extremity,	19
Width " " "	9
Diameter shaft below 3d trochanter,	10
Transverse width condyles,	18.6
Antero-posterior width of outer,	16.2
" " " inner,	12.2
" " " at popliteal groove,	8.6
" " " head of tibia,	22.8
Transverse " " "	11.5
Diameter head of fibula,	8
" condyle,	8.9
" cuboid (antero-posterior),	7
" head external metatarsus (long),	9
" median " "	9.8
Length external metatarsus,	32.8
Diameter condyle (antero-posterior),	6.8
Width of proximal phalange at middle digit,	7.6
" " inner digit,	4.
Length " " "	14.
Diameter extremity of ulna,	8.3
" " " radius,	6.3
Length outer metacarpus,	5.3
" third "	11.8
" second "	13
" first "	10.7
" proximal phalange of D. I,	8.2
" " " " D. II,	6.3
" ungueal phalange D. I,	16
Depth " " proximally,	8

Means of estimating the total length of this species are not very complete. Its not remote affinity to Compsognathus suggests that the neck could not have been short, though the generally more robust proportions than in C. longipes, would point to a shorter cervical series than in that genus. It will be safe to put the length at between four and five feet.

The remains here described were alluded to by Prof. R. Owen, as those of a Saurian pointing to the Pterodactyles or Birds, providing the cavities of the bones were filled by

marrow, and not by cartilage. Prof. Wyman regarded them as those of a reptile, though the long bones might have been referred to a bird if considered alone. "While the bones from Springfield are as hollow as those of the Pterodactyle, I do not find that they are those of this animal; there is no positive proof of the long fingers nor of the broad sternum which these reptiles possessed. The existence of the large toe in company with the small one is in favor of a jumping animal." (Ichnology of Massachusetts, 1858, 187.)

A figure of the right fore foot accompanies Prof. Hitchcock's description, of which it is to be observed that the metacarpals are too stout, and the carpals are omitted. The third phalange of the second toe is ungueal.

APPENDIX TO THE DINOSAURIA.

HYPSIBEMA, *Cope*

Char. gen. Proportions of limbs and feet much as in Hadrosaurus. The caudal vertebrae elongate and depressed, in the median part of the series.

The elongate depressed form of caudal vertebrae, distinguishes this genus from Hadrosaurus. The latter possesses elongate vertebrae near the extremity of the series, but anterior to this point, they are first subquadrate in profile, then proximally much narrowed. The form exhibited by the known species of this genus is more like that of Hylaeosaurus Mant.

HYPSIBEMA CRASSICAUDA, *Cope*.

The remains on which this species is founded consist of the distal extremity of the right humerus, a portion of the shaft of the left tibia, a portion of the fibula, the right internal metatarsus somewhat broken, and a caudal vertebra. There are other uncharacteristic fragments, and a piece which may be a dermal bone.

Associated with them are several coprolites of large animals.

These species indicate an animal of about the size of the Hadrosaurus foulkei, Leidy, and with a similar disproportion in the lengths of the limbs. This is readily appreciated on comparison of the huge metatarsus with the light humerus. The medullary cavity of the tibia is large; that of the humerus small.

The portion of the humerus preserved is injured, and the condyles are worn. Its relation to that of H. foulkei is readily determined, and on comparison the following marked differences appear: The ridge connecting the external condyle with the shaft posteriorly is acute; it is rounded in H. foulkei. External distal face is flat or slightly concave; in H. foulkei somewhat rounded. It is at right angles to the plane of the anterior face, and forms with it rather less than a right angle; in H. foulkei this region is rounded. Distally the shaft is much flattened in H. crassicauda.

Measurements.

	Lines.
Antero-posterior diameter of shaft, just above condyles,	20.5
Width external face distally,	24
" olecranar fossa,	16
" condyles, (estimated)	64

The anterior face at over three inches above the condyles is slightly concave. About 4.5 inches above the articular face of the external condyle, the acute ridge dividing the posterior and external faces disappears, and the surface becomes regularly rounded.

The portion of the tibia is from the shaft of that of the left side, just below the superior antero-posterior expan-

sion. Therefore the inner face is the most extensive, and the posterior the least so. It differs from the same part in H. foulkei, in its less angularity, especially in the more rounded, and less defined posterior face. The internal face narrows downwards, and while the greatest diameter of the fragment above is antero-posterior, below it is diagonal, the anterior point being the inner.

Measurements.	*Lines.*
Antero-posterior diameter above,	48
Transverse " "	22.5
" " medullary cavity,	20.5

The portion of fibula is the distal, and resembles that of Hadrosaurus foulkei, in being slightly expanded near the extremity, and cylindric in the lower part of the shaft. In both genera and Ornithotarsus, Cope, the distal extremity of the fibula is less attenuated than in Iguanodon.

	Lines.
Transverse distal diameter,	40.5
do. five inches above,	30

The right internal metatarsus also bears considerable resemblance to that of H. foulkei. Its proximal extremity is much more convex in its inner outline than in that species. The inner proximal face is plane and longitudinally wrinkled. The proximal or tarsal articular face is concave anteriorly; its plane is at right angles to the axis of the shaft of the bone. It is strongly oblique in Hadrosaurus foulkei, and a rib-like prominence of the outer face crosses the latter obliquely and at right angles to the proximal extremity. No such rib exists in the present case, because the weight was supported by the shaft of the bone, directly and not obliquely as in Hadrosaurus. Thus the Hypsibemae walked more exactly on the toes than did the Hadrosauri.

The posterior margin is thinner, and as in H. foulkei, presents a rather small median protuberance. The distal condyle is broken away, but the twist of the distal portion of the shaft shows that it was directed away from the adjoining metatarsal, posteriorly.

Measurements.	*In.*	*Lin.*
Length from antero-superior to postero-inferior extremity (inferior articular face worn away),	10	10
Transverse diameter proximally,	3	
" " medially,	2	3.5
Antero-posterior do. do.,	3	6

The diameters of the shaft are somewhat larger than in the H. foulkei given by Leidy.

The caudal vertebra is of large size and peculiar form. The centrum is considerably wider than deep, and considerably longer than wide. The posterior chevron articulations are small, and each is connected with each anterior by a strong rounded angulation. Between the latter the space is wide and slightly concave in transverse section, least so medially. A marked peculiarity is seen in the strong longitudinal ridge which divides the lateral surface of the vertebra into two nearly equal faces. The neural arch is elongate, the neural canal small, in section a short vertical ellipse. The articular face of the zygaphophyses makes an angle of about thirty-five degrees to the perpendicular. The crest of the arch rises a half inch behind these into the very stout basis of the neural spine, the greater part of which, with the posterior zygapophyses, is broken off. The inclination of the base is at about 65° to the vertical diameter of the bone. The articular faces are both slightly concave, as are the lateral faces which are separated by the lateral ridge.

	In.	*Lin.*
Length of centrum,	4	6
" " basis neural arch,	2	9
Width posterior articular face,	4	
Depth do. medially,	2	8
" " laterally,	3	3
" basis neural spine,		12
Transverse diameter neural canal behind,		10
Width between latero-inferior ridges,	1	9
" vertical, of face of zygapophyses,		11

There is a slight rugose protuberance in the position of the diapophysis.

The peculiarities of this vertebra indicate most strikingly the generic distinctness of this great reptile from the Hadrosaurus. It is true it presents some similarity in form to the terminal caudals of that genus, and if it could be referred to that portion of the series, would indicate merely another and larger species of Hadrosaurus. It differs in form from these vertebrae, in its depressed instead of compressed form, and its lateral angulation. That it belongs to a more anterior position in the tail is evident from the very large size of the basis of the neural spine, and general greater development of the neural arch and zygapophyses, and the trace of diapophysis. Further, it is over four times the size of the terminal caudals of H. foulkei, while the remaining elements do not indicate any such extraordinary dimensions. A position a little behind the middle of the series would relate well to the other proportions.

A worn bone found with the metatarsus, has the proportions of some of the dermal bones of certain Dinosauria. Its large size is appropriate to the present species. Its base is flat and with rounded outlines, and does not exhibit any superficial dense layer; the texture of the interior bone is rather dense. The mass of the bone rises as a short thick cone turned abruptly to one side, the middle and apex strongly compressed, so much so that the section presents an acute angle on that side to which the apex curves. The bone is not entirely symmetrical, one side near the posterior keel being more concave than the other. The structure of the bone is rather dense. Its exact position is somewhat uncertain.

	In.
Diameter at base,	3
Greatest height (apex broken),	2.5

This is another of those remarkable forms which the reptilian type developed in past ages. That it was herbivorous, and relied less on its tail for support than Hadrosaurus, appears probable. Large coprolites of the character of those of herbivorous animals accompanied the bones. They resemble somewhat those of the hog; one has a diameter of inches one way, and inches the other; extremity broad, obtuse. The probable form of the ungueal phalanges, points also to the same habit. The proprietor of the pit told the writer that he had more than once seen large "hoofs" and "wide toe-joints" taken out during the excavation.

This species is different from the Ornithotarsus immanis, Cope, and belongs to a different genus. The shaft of the tibia in the latter is filled with cancellous tissue; in the present animal it is entirely hollow.

From the marl pits of James King.

HADROSAURUS, *Leidy.*

HADROSAURUS TRIPOS, *Cope.*

At a point about ten miles distant from the marl pit in which the Hypsibema was found, Prof. Kerr discovered a caudal vertebra of a colossal reptile, whose affinities are evidently near to the Hadrosaurus foulkei.

This vertebra is one of the distal, as evidenced by the entire absence of any trace of diapophysis, and its subquadrate longitudinal section, as well as by the small size of the neural arch and spine. At first sight it would appear to occupy a position between the thirtieth and thirty-sixth of the series; the former in H. foulkei has, however, rudiments of a diapophysis. Both its articular faces are distinctly biconcave. The large size of the chevron articular face is as in the thirtieth, and the concavity of its lateral faces as in the twenty-sixth; in the thirty-sixth the sides are entirely plane. The round form of the neural canal, as well as lack of diapophyses, are points of resemblance to the thirty-sixth, but it is more than twice as long as that vertebra in the H. foulkei. In the thirtieth the neural canal is somewhat depressed and becomes more so as we advance towards the proximal part of the series. The small antero-posterior extent of the neural arch is much as in the thirtieth in H. foulkei, but the basis of the neural spine, which is broken off in this, as well as the old species, is much more slight. It is so very thin and weak as to indicate either a comparatively slight development of the spine, or a very posterior position in the series. A weak lateral ridge marks the

side of the centrum, which is below the middle line. It holds the same position in the thirty-sixth in H. foulkei, but is above the middle in the thirtieth and those anterior.

Measurement.	*In.*	*Lin.*
Depth centrum to summit chevron articulation,	5	
do. from neural canal without chevron face,	4.	
Greatest width do.,	4.	9
Length centrum,	4	3
do. neurapophysis,	2	6
Width between anterior zygapophyses,	1	3
do. of arch above,	1	6
do. neural canal,		10
Depth do. do.,		10
do. basis neural spine,		5

This specimen was procured from the marl pit of W. J. Thompson, Sampson co., N. Carolina.

A second and much smaller vertebra from the pit that furnished the remains of Hypsibema crassicauda, belonged to a third individual, and possibly to this species. Its proportions would point to a position near the end of the tail, and its form is less elongate and compressed than those in that position in H. foulkei. Its neural arch is not coössified. The extremities are slightly concave, the general form subquadrate.

	Lines.
Length of centrum,	20.5
Diameter extremity, (vertical)	18.
" " (transverse)	21.5
" middle, "	15.

The first named vertebra pertained to an immense species, perhaps double the Hadrosaurus foulkei in weight and bulk, should the general proportions of the two have been at all similar. In that case the length of the femur would be sixty-two and a quarter inches. It will remain for future discovery to determine whether the species is the same as the Ornithotarsus immanis.

HADROSAURUS MINOR, *Marsh.*

Proceed. Acad. Nat. Sciences, Jan. 1870, Nature (London), Jan. 1870.

This species is represented by two dorsal, four lumbar and a caudal vertebræ, from Barnesboro, Gloucester co., N. J., and another dorsal from another locality. These belonged to an animal of about half the size of the H. foulkei, and not fully grown, excepting the last mentioned, which belonged to an adult. The dorsals are much compressed, and slightly concave in front and convex behind; the inferior surface not distinctly keeled. The lumbar is short, much broader, being subdiscoid, and distinctly convex anteriorly and concave behind: below, it presents a narrow prominent carina. The caudal is anterior and is discoid and short; the diapophyses with neural arch are lost, not having been coössified; the former was at the base of the latter. Articular faces nearly plane. Articular surfaces for chevron bones small. Inferior face not excavated.

The upper bed of Cretaceous Green Sand.

LAELAPS, *Cope.*

LAELAPS AQUILUNGUIS, *Cope.*

Maxillary bone. The form of the maxillary bone described on page 100, indicates a short elevated and narrowed muzzle, as in Teratosaurus.

Ischia. The elements described on p. 108 as pubes, are probably ischia. As in Megadactylus, they appear to have been directed backwards, and to have been in close contact for a considerable part of their length. On plate X, fig. 4, the surface of contact or symphysis, is represented on the inferior part of the distal two-thirds the length. The anterior, dilated portions diverge, leaving a V-shaped interval, and extend to the acetabula. This union of the ischia, which are of very dense structure, furnished some support for the animal in a squatting position, as is indicated for some of the species of the Connecticut Sandstone.

TESTUDINATA.

CRYPTODIRA.

EMYDIDAE.

EMYDINAE.

STYLEMYS, *Leidy*.

Stylemys, *Testudo* and *Emys*, Leidy, Proceed. Ac. N. Sci., 1851, 172. *Testudo*, Leidy l. c. 1852, 59. Smithson. Contrib. to Knowl., 1852, 103.

The species which I refer to this genus, are Emydoids with the usual elongate form of digits which characterizes the aquatic species, but with a single caudal marginal scutum, as in Testudo. Another Emydoid genus which approaches Testudo most, is Manuria, Gray. Here however the anal marginal plate is divided, and the pectoral plates do not meet on the median line. In Stylemys the latter are only narrowed.

The ilium is formed much as in Chelydra, somewhat dilated proximally in a posterior direction. The pubis is like some Emydoids in the length and lateral direction of its lateral process, while its stout form, with distal dilatation, articulated with its fellow on the median line is like that of Chelydra.

A right femur is entirely Testudinoid, and presents one peculiarity which I have only observed in Testudo polyphemus. The great trochanter (which is always large in the Testudinata) extends entirely round from its origin, to near the head of the femur, embracing a marked fossa. In other genera the greater tuberosity with the lesser enclose a fossa-like groove, which separates them entirely.

The capitula of the ribs extend to the vertebræ, but not to their centra; they are in contact with the laminiform neural spines.

A marked character of the genus also consists in the considerable separation of the neural arch from the vertebral carapacial bones. It is suspended as it were, some distance below them by the laminiform elevation of the joined neurapophyses, which are united by suture to the similar thin plate-like neural spines, which descend from the transverse vertebral expansions. The depth of this vertebral septum is greater than the length of each vertebral bone, behind the middle of the column. The centra are very thin as in Cistudo.

Leidy named some individuals of one of the species, Stylemys, while others were referred to Emys. As he gave no characters to it, and afterwards abandoned it, referring the species to Testudo, I only adopt the name for the purpose of diminishing the synonymy.

STYLEMYS NEBRACENSIS, *Leidy*.

Stylemys nebracensis, *Emys hemispherica* and *E. oweni*. Pr. A. N. Sci., Phila., 1851, p, 172.

Testudo nebracensis, Leidy, Ancient Fauna Nebraska, 103. *T. hemisphærica*, T. *oweni* et T. *lata*, Leidy l. c. Tabs. xix, xx, xxi, xxiii, xxiv.

Miocene Tertiary of Nebraska.

A specimen of this species presented to the Academy of Natural Sciences by Dr. Hayden measures 20 inches in length, and 15 inches in width.

STYLEMYS CULBERTSONII, *Leidy*.

Testudo culbertsonii, Leidy, Ancient Fauna of Nebraska, Tab. xxii.

Miocene Tertiary of Nebraska.

STYLEMYS NIOBRARENSIS, *Leidy*.

Testudo (St.) niobrarensis,, Leidy, Proceed. Ac. Nat. Sci., Phil., 1858, 29.

Pliocene of the Niobrara river, Nebraska.

COMPSEMYS, *Leidy*.

Proc. Ac. N. Sci., 1856, 312.

The remains of this genus do not offer any very marked features to distinguish them from Emys. The existence of generic distinction is however suggested by the delicate areolate sculpture of the surface of the carapace. Costal capitula well developed; vertebral scuta subquadrate.

COMPSEMYS OBSCURUS.

Emys obscurus, Leidy, Pr. A, N. Sci., 1856, 312.

From the Upper Jurassic of Long lake, Nebraska.

COMPSEMYS VICTUS, *Leidy l. c.*

Upper Jurassic Bad Lands, Judith River, Nebraska.

CISTUDO, *Flem.*

CISTUDO EURYPYGIA, *Cope*.

This extinct species is represented by a portion of the posterior margin of the carapace, which includes more or less of four marginal, two vertebral, and one costal, scuta. The relations of the osseous elements are much as in C. clausa; *i. e.*, the posterior costals are united on the median line, without rudimental vertebral below, and the last vertebral is an irregular pentagon with the two anterior sides elongate. There are traces of angular concentric sculpture as in the existing species, which encloses a slightly angular boss on the posterior margin of the costal scutum.

What distinguishes this box-tortoise from the existing one, is the greater width of the vertebral scuta, and the different form of the marginals. The costal suture of the vertebral, instead of joining a prolongation of the penul-

timate marginal, joins a superior angle of the antepenult. The superior margin of the penultimate is straight, and but little elevated above the caudal pair. From this increased width of the last vertebral, its lateral suture is more oblique, and what remains of the lateral suture of the penultimate vertebral is still more oblique, indicating a still wider scutum. The posterior vertebral bone is a little more elongate than in several individuals of C. clausa.

The posterior margin is not recurved, but is vertical, and therefore from a female animal. There are no emarginations or processes. On the inferior aspect, the concavity which receives the crest of the ilium is deeper and nearer the margin than in C. clausa.

This species was found by Samuel R. Harrison, M. D., of Easton, Md., on Oxford Neck in Talbot Co., Maryland, in connection with postpliocene fossils, as follows: Elephas americanus, Cervus canadensis, Cariacus virginianus, Chelydra serpentina.

Remains of a Cistudo occur in the postpliocene bone breccia of caves in S. W. Virginia, but whether they belong to C. clȧusa or some other species is not as yet determined.

EMYS, *Brongniart.*

The only species of this genus which I have had the opportunity of studying are the three following from the cretaceous green-sand of New Jersey. They agree in the massive thickness and dense structure of plastron and carapace, which peculiarity suggests doubt as to their aquatic habitat, and enquiry as to whether they may not have been more or less terrestrial. Their reference to Emys is provisional, as the limbs, cranium and caudal marginal scute are unknown. In E. petrosus the heads of the posterior ribs are rudimental as in Adocus.

The species may be distinguished as follows:

Sutures of hyo-and hyposternal bones, coarse and ragged; hyosternal nearly twice as thick anteriorly as posteriorly; eighth marginal acute edged, its width 11–12 length hyosternal, its depth 5–4 the same.

E. FIRMUS.

Sutures minutely rugulosc, hyosternal thicker anteriorly; eighth marginal with thick obtuse edge, depth 3–4 length hyosternal, its width .55 same; superior plane of hyosternal transversely as wide as a costal, inferior plane very convex; mesosternum width .66 length of do.; size medium.

E. PETROSUS.

Sutures minutely rugulose; hyosternal thickest posteriorly, its inferior face plane, superior plane twice as wide as a costal; width of mesosternum 6–7 length, and width of eighth marginal .05 length of same; size smaller;

E. TURGIDUS.

EMYS FIRMUS, *Leidy*.

Cretac. Rept. 106, Smithsonian Contrib., No. 192, *Adocus firmus* Cope, Proceed. Acad. Nat. Sci., Phil., 1868, 235, Geolog. Surv. N. Jersey, App. C.

An individual of this species is represented by same characteristic fragments in the Museum of Rutger's College, N. J. As remarked, they have many characters like the following species; while in the surface markings, dermal scutes, etc., they resemble as much the Adocus beatus. I have not seen the costal bones.

This is a large species and of extraordinarily massive construction. This was no doubt an adaptation in defense of enemies, perhaps as protection from blows or snaps of the more gigantic reptiles of that time. I give the measurement of this species from Leidy.

	In.
Length margin 7th and eighth marginals,	5.75
Width seventh plate,	2.5
" eighth "	2.75
Depth "	3.75
Left hyosternal, length from exterior angle mesosternum ,	3.
Thickness at latter suture,	1.+
" postero-medially,	.625

This species is distinguished from both the following by the relatively much larger size of the postero-median, and probably the other marginal bones. Its points of resemblance to the E. turgidus are more numerous than to the E. petrosus. Like both of these the mesosternum is truncate behind.

Position. The upper bed of Cretaceous Green Sand, New Jersey.

EMYS PETROSUS, *Cope*.

Adocus petrosus, Cope, Proc. Acad. Nat. Sci., Phila., 1868, 236, Geol. Surv. N. Jersey, App. C.

This species is represented by portions of four costal bones, parts or wholes of six marginal bones, most of the right hyosternal, and a posterior portion of the right hyposternal, with the head of the os coracoïdeum. They were found in the West Jersey Marl Company's pits, Gloucester Co., N. J., in the same locality whence the Laelaps was procured. It is characterized by the very massive structure of its carapace and plastron, and for the posteriorly truncate form of its mesosternum. Another species (E. firmus) which unites the same peculiarities, is included in this genus, though I have not seen its costal bones.

The hyosternal bone is preserved in its axillary margin, and is continuous with two marginals of the carapace of the same side. Two of the costals are adjacent and give the outlines of the vertebral bones and scutes. These show the inferior outline to be very convex, the whole, from angle to angle of the marginal bones of opposite sides amounting to an arc of about 124 degrees. Each hyosternal is slightly concave below the plane of their common suture. Each thins out laterally, though the one preserved is very thick on the axillary margin. There is little difference between the thickness at the mesosternal and the hyposternal sutures. All the sutures have minute rugosities, differing much from sternals in Adocus and Taphrosphys, which are very ragged, and resembling those of Pleurosternum pectorale m. The piece of hyposternal is even thicker than the hyosternal. The

bone is everywhere remarkable for the thickness of its dense layer, and the closeness of the texture of the spongy. The former is one-third the thickness of the sternal and costal bones fractured.

The scute sutures of the inferior surface are obsolete; those of the dorsal surface are like those of Adocus; *i. e.*, the vertebrals with bracket-shaped lateral borders with the costal proceeding from the point of the bracket.

The marginal bones vary much in thickness proximally; they have two proximal sutures, one side convex, the other concave. Four have a heavy border, round in section; in two of these it is considerably everted: another has a rather thin margin, slightly decurved, with a submarginal groove separating it from the most massive portion The costal bones are strongly convex in their length, indicating an arched carapace.

Measurements.	*In.*	*Lin.*
Hyosternal width,	3	9.
" " to origin axillary abutment,	2	1.5
" length on median suture,	2	1.5
" thickness near mesosternal line,		9.
" " " hyposternal "		7.2
Hyposternal thickness near poster. suture,		9.
Costal, width,	1	7.5
" thickness vertebral suture,		8.
Marginal No. 1 width,	2	1.5
" " length,	1	7.
" " proximal thickness,		3.
" No. 5 " "		8.2
" " length,	1	6.
" " width,	1	7.5
" " width dermal scute,		9.

This animal is therefore a species of considerable size, though less than most of those described here, and particularly convex and solid in every part. While the sutural lines of the hyosternal measure about the same as in E. firmus (Emys Leidy), it is much more convex and not so thick at the mesosternal suture. The marginal bones are relatively just half the size. The Pleurosternum pectorale, differs in being very much flatter, and in having a more discoid mesosternal bone. The hyosternals are also much thicker at their union with the marginals, than the present is.

A portion of a hyo-or hyposternal bone collected at the same place, and near or at the same time, may be referred to a larger individual of the same species or to E. firmus. It exhibits a wedge for a diagonal gomphosis, between the two sutures, which are preserved. The thickness on the median suture is 14 lines.

The density of the sternal bones is in marked contrast to that of the E. crassus according to Owen, where the structure is remarkably spongy and open.

EMYS TURGIDUS, *Cope*.

This species is represented by two individuals in a more or less fragmentary condition in the private collection of Dr. Samuel Lockwood, of Keyport, N. J. One of these, selected for description, embraces proximal portions of four left costal bones and of three right ones, with a vertebral, other fragments of costals, four marginals (one from the bridge), the greater part of both hyosternals and the mesosternum.

These indicate a species of about half the bulk of the E. petrosus, and differing in many particulars. These are especially the relatively much wider and flatter, hyoster-

nals, and thinner edged more recurved marginals. The size of the marginals is similar to those of the last, while the mesosternal element is larger. The scutal sutures are better preserved than in the type of E. petrosus, nevertheless none are preserved on the lower surfaces except that which divides the mesosternum longitudinally throughout. The vertebral scuta are $\frac{2}{3}$ as wide as long, and have longitudinal borders, which are scarcely produced at the junction with the intercostal suture, and are otherwise somewhat irregular. The carapace is swollen in an interrupted line bordering the vertebral scuta externally, leaving the median parts of these smooth. The marginals are also slightly swollen just within the costal-marginal sutures. The marginal bones are concave externally, and thickened inferiorly at some distance within the margin. That from the bridge is angulated at one extremity at 45°, at the other less. The union of the hyosternals behind and with the mesosternal behind, is by a groove and keel suture. The mesosternal is much thinner anteriorly than posteriorly.

			In.
Length heads of four costals,			4.375
" vertebral,			1.06
Width	"		1.
Length hyosternal,			2.4
"	"	from mesosternal,	1.8
Thickness	"	at "	.65
"	"	posteriorly,	.7
Length vertebral scutum,			2.3
Width	"	"	.75

From the upper Green Sand Bed, Cretaceous N. J., at Hornerstown, N. J.

EMYS PETROLEI, *Leidy*.

Proceed. Academy, 1858, Postpliocene, Harden Co., Texas.

A very distinct species, probably of the more terrestrial type of the genus, as Chelopus, etc.

ADOCUS, *Cope*.

Emydoid tortoises in which the rib heads of the posterior costal bones are represented by a rudimental lamina, and the anterior by a crest or truncate ridge in addition. Vertebral scuta narrow; external surfaces smooth or nearly so.

Name from *Α* privative and *Δωκος* rafter (*i. e.*, rib head).

This genus, formerly characterized, differs from Emys in the absence of costal capitula of the costal plates of the carapace, a feature pointed out by Leidy in the type species.

It also possesses a character of Pleurosternum in the presence of a series of marginal dermal plates on the sternal bridge. It belongs to the true Emydidae, having the eight paired sternal bones instead of ten of the first mentioned. The markings of the dermal plates of the plastron are not distinct.

ADOCUS BEATUS, *Leidy.*

Emys beatus, Leidy, Cretaceous Reptiles, Smithson, Contrib. 1804, 107.

Remains of a considerable portion of the plastron and carapace of this species from the marl excavations of David Haines near Medford, N. J., furnish important characters, as already indicated. The posterior lobe of the sternum is long and flat, and strongly emarginate behind; its greatest length is 5 in. 9 lin., greatest (anterior) width 5 in. 8 lin. The thickness of the hyosternal bones is a little greater at the sides than at the median portion; latter measurement 7 lines; all the pieces of the plastron are thicker than those of the carapace.

The anterior lobe of the sternum in A. beatus would appear to have been more or less moveable.

ADOCUS PRAVUS, *Leidy.*

Emys pravus, Leidy, Proceed. Ac. Nat. Sci., 1856, 312, Cretaceous Rept. Tab.
Middlebed, or upper Cretaceous green sand New Jersey.

This species is referred here because of its general resemblance to the others of the genus. Its costal bones have not yet been procured.

PLEUROSTERNUM, *Bell.*

Some of the Emydinae of the New Jersey Green Sand exhibit only faint impressions of the usual horny dermal plates. It is probable therefore that such were covered with coriaceous plates as in the genus Dermatemys and some species of Hydraspididae.

The species which is referred to Dermatemys, D. mavei Gray from Mexico, is further distinguished generically by a series of marginal plates between the axilla and groin on each side, within the usual marginal series. The same peculiarity characterizes also the genus Macrochelys, which has however no affinity with the present.

The hyosternal bones, quite perfectly preserved, of an aquatic tortoise, from the farm of David Haines near Medford, present the double marginal series of Dermatemys. It differs from the species of that genus in the apparent fusion of the pectoral and humeral dermal scuta, a peculiarity which I have not seen in any modern genus of Emydidae or Hydraspididae. This is characteristic of Pleurosternum, and the scuta are really distinct, the pectoral having an unusually posterior position, on account of the intercalated sternal

bone. The hyosternals are prolonged forwards, extensively embracing the mesosternum; the latter piece is subcircular, and truncate behind. The episternals and mesosternal are lost. The extreme anterior lip of the hyosternals is crossed by a groove, apparently the suture of the gular plate; it has reached the external margin a half inch in front of the posterior margin of the episternal. This would leave sufficient width for an intergular plate, which would refer the genus to the Hydraspididae. As however the other pieces of the sternum have been found in England, it is certain that the genus is Cryptodire.

PLEUROSTERNUM PECTORALE, *Cope sp. nov.*

The plastron of this species is massive, and three times as thick in the middle as at the sides. The posterior hyosternal suture has been immoveable, and its rugae are minute. The anterior or axillary buttresses have risen higher on the costal plates, and are directed obliquely forwards. The axillary outline is deeply concave. The external surface is without sculpture. Behind the truncate axillary plate is one long hexagonal inner marginal, while the anterior third of a second is truncated by the posterior suture. The posterior humeral dermal suture, approaches the hyosternal suture towards the median line but slightly.

	In.	*Lin.*
Width of a hyosternal,	3	
Depth at middle, on hyost. suture,		10.
" outer end " "		2.8
Length median suture,	1	6.4
From posterior suture to axilla,	1	4.6
Antero-posterior extent hyosternal (exclus. sutural process),	2	2.5
Width inguinal scute interiorly,		4.
" " " externally,		8.5

The inferior surface of the plastron is convex, the interior nearly plane.

The species was about the size of the Ptychemys rugosa Ag. of the Delaware. It is distinguished from the Emys pravus of Leidy by the transverse hyosternal suture, the greater transverse extent, and thickness of hyosternals. In A. firmus Leidy the humero-pectoral dermal suture is anterior, and the mesosternal is transversely truncate behind.

CHELYDRINAE.

The extinct species of this group indicate a successional relation of forms such as the theory of evolution would anticipate.

Those of the Miocene and Eocene periods in America are not known, but so far as they are in Europe, they resemble those of the present. In the cretaceous, the genus Propleura appears, which approximates the genus Chelone in the probable more natatory character of the fore limb than in Chelydra; the humerus has a more flattened shaft, and is not quite so much curved as in the latter; its proximal condyle and crests are those of Chelydra, and this point has chiefly decided me in referring the genus to the neighborhood of the latter, rather than to the Cheloniidae. The independence of the Cheloniidae rests entirely on the structure of the fore limb, for its other peculiarities are repeated by genera in various other families. The natatory character has a strong ex-

pression in the form of both humerus and femur, and decided by this test, the genera following are all Chelydroid Emydidae.

The metatarsals of the hind foot preserved, indicate a broad natatory member more like those of Trionyx than those of Chelydra.

At the same time the vertebral dermal scutes have the most narrowed form characteristic of various genera of Emydidae. The femur has a slender curved shaft as in Chelydra and Chelys. The sternum is more that of Chelydra than of the sea turtles. This is seen in the narrowness of the sterno-carapacial bridge, which is very wide in Chelone, and very narrow in Chelydra. In the cretaceous genera, the width is intermediate, and the hyo and hyposternal bones are united medially, and are not merely prolonged anteriorly and posteriorly as in Chelone. The lateral sternal regions were therefore less protected than in the sea turtles, while the general small size and form of the sternal bones also point to the cross-shaped plastron of Chelydra.

It does not offer any approach to the Pleurodira, since the xiphisternum is free from the pelvis. The cranium of the genus Euclastes, which belongs here, shows the technical details of the Cheloniidae, with the form of head, physiognomy, and no doubt, the carnivorous adaptations of Chelydra. In the genus Osteopygis, also of the cretaceous, the characters diverge still more from those of the modern sea turtles. Here five marginals in front and three behind, are united with the disc. The anterior marginal scutum becomes united with the first vertebral. In other respects the characters are those of Propleura. In Lytoloma the marginals are free as in Chelone.

Several genera have been discovered in the lithographic slates and other strata of the Jurassic period in Germany, Switzerland and France. These have been described by Münster, Wagner,* and Von Meyer.† Some of these are allied to Chelone, but the majority of them appear to me to have a near relationship to Chelydra, and to those herein described. This has been scarcely alluded to by the learned authors quoted, and in general their affinities to existing forms have been but obscurely indicated. Those which I would refer to this neighborhood are:

EURYSTERNUM Münst.
  E. wagleri Münst.
  E. crassipes Wagn. (*Palaeomedusa* Mey.)
  E. redtenbacheri (*Acichelys* Mey.)
IDIOCHELYS Mey.
  I. fitzingeri Mey.
  I. wagneri Mey.
HYDROPELTA Mey.
  H. meyeri Thioll.
PLATYCHELYS Wagn.
  P. oberndorferi Wagn.

* Abhandl. d. m. ph. cl. K. Bayerisch Acad. Wiss. IX.

† Reptilien o. d. Lithograph. Schiefer.

Eurysternum differs from Chelydra as Osteopygis does, in a greater coössification of the discal and marginal bones anteriorly and posteriorly. It differs from the latter in the stout ambulatory foot like that of the Chelydra, and in the apparent absence of the temporal osseous roof, which I suspect Osteopygis to possess. The vertebral dermal scuta are wider than in any species of our genera, but this is but a specific character.

In Idiochelys the marginal bones are more distinct from the disc, entirely so posteriorly; there are numerous omissions of the vertebral bones of the carapace; this does not occur among our species so far as known.

Hydropelta is in general much like Osteopygis, but in it the hyo and hyposternal bones, have an articulation by gomphosis with the third and tenth marginals respectively, a character certainly wanting to the American genera. There is also no median sternal fontanelle, which is present in our types.

Platychelys has a still greater union of carapacial disc and margin; only three ribs have free extremities on each side.

Our forms then appear to differ from those of the Jurassic of Europe, up to the present time. It is important to observe, that instead of being of marine habit as has been supposed, they are representatives of modern fresh water species, and were probably inhabitants of brackish estuaries of our coast.

OSTEOPYGIS, *Cope.*

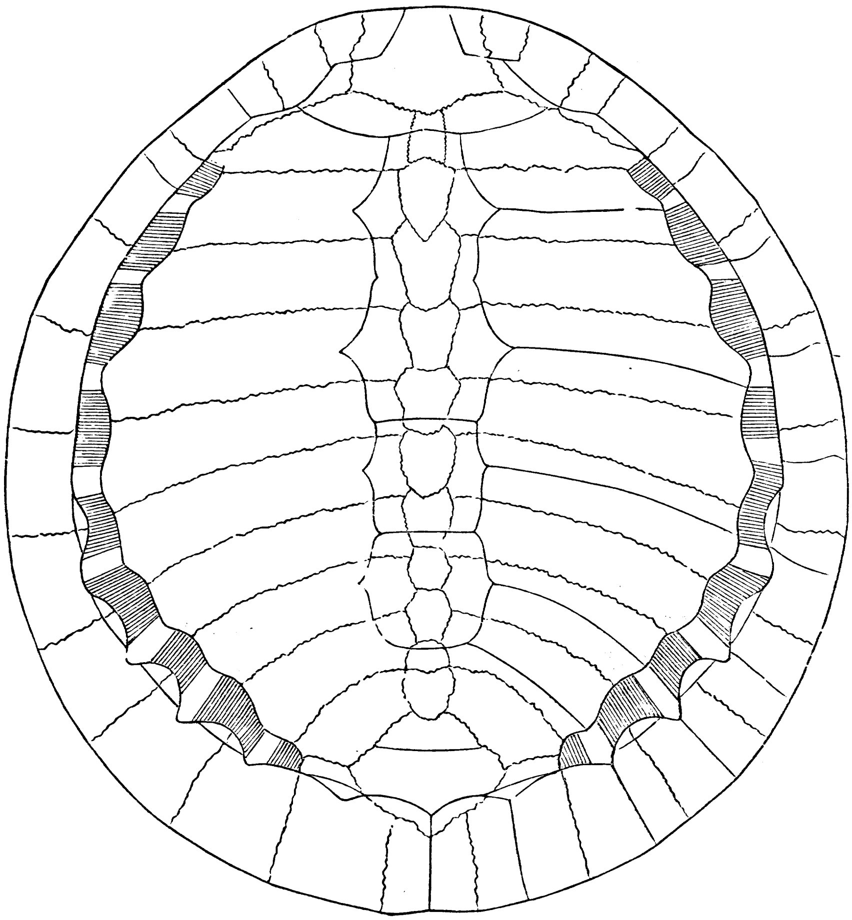
Proceed. Acad. Nat. Sciences, Phila., 1868, 147.

This genus has been characterized above, in part. It has the usual twenty-three marginal bones with ten costal bones on each side, nine of which send their free extremities for gomphosis with the marginals. Though in sutural union with the second marginals, each sends a costal process into a corresponding pit of the latter. The intercostal union is prolonged, and the vertebral scuta are rather narrow, and do not therefore extend far on the former. The four posterior marginals are prolonged considerably within the groove marking the suture of the costal and marginal scuta. The posterior marginal plates of all the species are very flat and expanded, the lateral on the contrary trigonal or subtrigonal in section, with a distinct inferior plane.

The accompanying cut gives the characters of the genus as exhibited in the carapace of the typical species. The dermal sutures are omitted from the left side, so as to show more clearly those of the skeleton.

The plastron of Osteopygis is more like that of Chelydra than any other known genus. The hyo-,hypo, and xiphisternals are united on the median line by a coarse open suture as in that genus, and are not separated as in Chelone. They are much more united than in Trionyx.

Fig. 38.

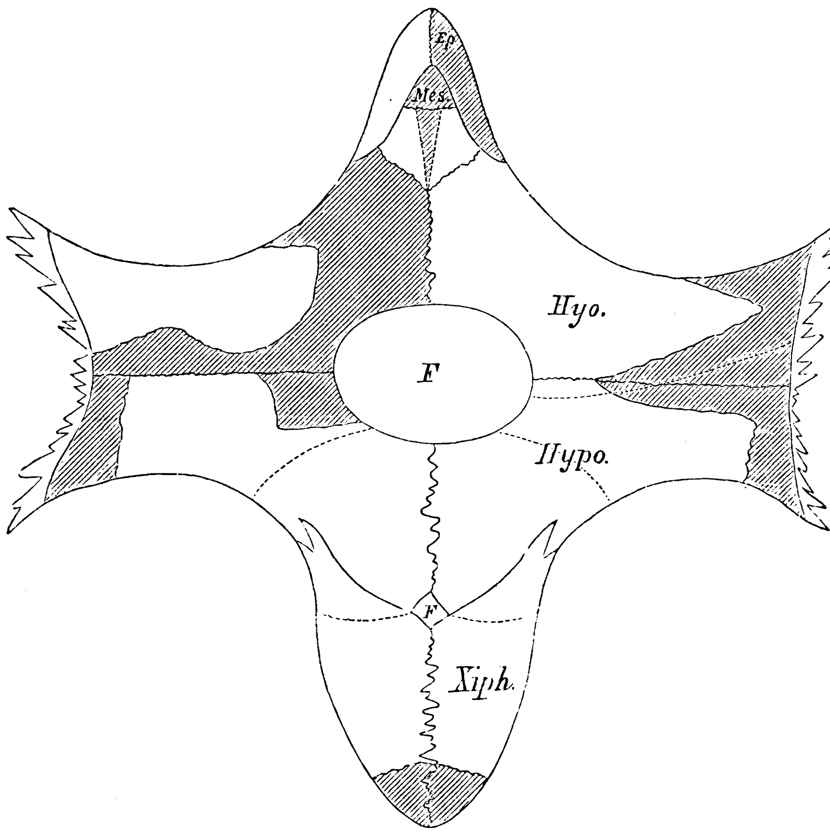


OSTEOPYGIS PLATYLOMUS carapace.

The xiphisternal is united with the hyposternal precisely as in Chelydra, that is, by a mutual marginal gomphosis at the anterior extremity of the former, its peg being the external; and by a deep groove in the inner margin of the xiphisternal, which receives the adapted margin of the hyposternal. The xiphisternal lobe is wider than in Chelydra, while the bridge is very much wider, being about as in Trionyx, and much narrower than in Chelone. This constitutes a point of separation from the first named genus. There is a median fontanelle, larger than in Chelydra serpentina at the junction of the four sternal elements. The external margin of the hyosternal, is free and serrate as in Chelydra. The mesosternal has not been identified, but the episterna are narrower and greatly incurved, more as in Chelydra and Chelone than as in Trionyx. In the accompanying restoration, the shaded portions are those which have not been pre-

served. The outlines of the episterna are not entirely demonstrable. The scale is near that of the carapace preceding, but is a little too large.

Fig. 39.



OSTEOPYGIS PLATYLOMUS plastron.

Dermal sutures are visible in the two species whose sterna we have. Abdominal and inguinal plates can be demonstrated; the anterior are not distinguishable. If anal scuta exist, they must be very small, but they are probably absent as in Chelydra.

Some of the Eocene Chelones have the posterior vertebral plates more dilated than in the recent species, but they all present the penultimate marginals supported by a distinct pair of ribs, and the anterior marginals separate from the disc, and without rib.

The femur of a presumed species of the genus is more slender than in the Chelones, but resembles closely that of Trionyx, while two phalanges of the same are peculiar in their stout base and subterminal constriction. They are however flattened and have transverse distal condyles, being thus rather adapted for paddles than for progression, thus showing the genus to have been truly aquatic.

There appear to be remains of three species in our collections distinguished as follows:

I. The margins of the posterior marginal plates continuous, either notched or even medially.

a The rib-fossae of the marginals flat; ? no nuchal scute.

Upper margin of inner face of (7th and 8th) posterior marginals much produced; lower margin not prolonged. Lower margin of 5th and 6th marginals not projecting, their inner face vertical. Outer face of narrow marginals convex or little concave, their scuta $1.\frac{2}{3}$ long as wide. Eighth marginal $\frac{4}{5}$ wide as long. PLATYLOMUS.

aa The rib-fossae of the *lateral* marginals cylindric; a nuchal scute.

Upper and lower margins 7th marginal both prolonged; lower margin 5th very much produced inwards giving a horizontal inner, as well as outer face; outer face of narrow marginals concave except the anterior; scuta of latter $1\frac{1}{2}$ long as wide; 9th marginal $\frac{7.5}{6}$ wide as long; 5th marginal nearly .75 wide as long. EMARGINATUS.

II. Margins of the posterior marginal plates acuminate medially.

Posterior lateral bones short, wide, width greater and length, pit round, margin strongly repand; anterior laterals less confluent with disc, strongly concave on outer face. CHELYDRINUS.

OSTEOPYGIS PLATYLOMUS, *Cope Sp. Nov.*

This species is represented by portions of two individuals, first perhaps half the carapace and plastron with all the marginal bones of one side, and many of those of the other, of a large individual from the Pemberton Marl Company's Pits, Burlington Co., N. Jersey, presented to the Academy by Dr. Samuel Ashhurst; the second, a few portions from the pits of David Haines, near Medford, Camden Co., N. J.

The carapace is flat, as indicated by the slight curvature of numerous costal bones, and without keels, as indicated by an anterior and two posterior vertebral bones. The posterior and adjacent margin is flat and wide, extending to a thin edge. The anterior vertebral, has the anterior margin entirely forming a deep notch, extending to nearly opposite the lateral angles of the bone a feature not seen in the genus Chelone. It is crossed not far from its middle (it is broken behind) by the dermal suture. The posterior vertebral is transverse, occupies a concavity formed by the three posterior marginals, extending to beyond the middle of the penultimates on each side. The posterior vertebral dermal scute is of great width, its outer suture not reaching the marginals on any of the bones just mentioned. The anterior vertebral scuta as seen on numerous costal bones, were of peculiar form. Their borders diverged very little at their anterior and posterior portions, but curved outwards abruptly to meet the costal dermal suture, forming an acute angle.

Marginal bones heavy at the sides and in front, the former concave on the upper face, the lower face plane but upturned at the edge. Front laterals convex below with broad rounded margin; none of these projecting above the marginal dermal suture except to form suture with costal plate as in C. repanda. This suture first appears on the middle of the tenth marginal bone counting the lateral caudal as first: marginal bones eleven on each side, all with equal lengths, as in Cheloniidae.

The rib pits are flat, very much so medially, the anterior one more nearly cylindric.

The width of the marginal scute on the ninth and tenth marginal bones, is 1.66 its length, measuring from the obtuse margin. The width of the first (posterior) scute is nearly equal to its length.

The surface of the bone generally is marked by small irregular straight grooves.

Portions of the sternum are parts of two hypo, a hyo–, and xiphisternal. The hyposternal of the left side has a

less antero-posterior extent between the groin and transverse suture than in the species of Chelone. Its transverse extent at the same region is greater, implying a greater closure of the sternal fontanelle. It presents on its outer posterior margin a pit for articulation with the xiphisternal by gomphosis. The hyosternal of the right side is much heavier than the last, and has a bevelled outer anterior face, where it rises steeply to meet the marginal bones of the carapace. Its sutural margin is broken away. The xiphisternal is broken at both ends; it is flat and rather thin. A large part of its inner margin is fitted for articulation with the long hyposternal. Its thin outer margin is contracted gently, nearly opposite the middle of the posterior fontanelle.

There are no distinct dermal sutures crossing these. The nuchal marginal scute is confluent with the first vertebral.

Measurements.	*Ft.*	*In.*	*Lin.*
Length of second marginal,		2	10.2
" eleventh "		2	11.1
" caudal "		3	3.7
Width of second "		1	11.
" eleventh "		3	9.5
" caudal "		2	7.2
" sixth, infer. face (average),		1	9.
" last vertebral,		2	4.
" an anterior do.,		2	2.
" episternal,		2	5.5
" hyposternal (longitudinal),		2	4.
Length inner suture episternal,		2	8.
" free rib,		1	5.
Width costal bone distally,		2	11.5
Length carapace (estimated),	2	2	
Width " "	2		

OSTEOPYGIS EMARGINATUS, *Cope Sp. Nov.*

Of this species a considerable portion of carapace and plastron were discovered near Barnesboro, and deposited in the Museum at Rutger's College by the State Geological Survey of New Jersey, under Prof. Geo. H. Cook.

It is near the O. platylomus, but differs in the greater width of all the marginal bones in relation to their length, in the greater prolongation of the inner edge of the lower face of the lateral marginals, and in the cylindrical ribs and rib pits of the lateral marginals. In the O. platylomus the rib pits are everywhere alike, entirely flat and longitudinal.

A vertebral osseous plate is strongly emarginate anteriorly, as in the last species, but not to more than half the depth; the piece is more elongate, especially the antero-lateral or short sides which enter the greatest width twice, in the platylomus $2\frac{2}{3}$ times. In this specimen it is not crossed by a dermal suture; in the other it is, hence the plates compared are not the same, but probably are only adjacent. A costal bone exhibits the head of an anterior rib, which has a strong spongy crest on its anterior margin. The anterior sutural margin converges outwardly towards the posterior margin, which is parallel with the rib axis. On the upper surface the sutures of the plates are distinct; the anterior vertebral is very divergent, making an angle of 45° with the median line. The anterior suture of the posterior plate of the two is less divergent. Three junctions of posterior and anterior vertebral scute sutures with the costals, compared with two similar junctions in the O. emarginatus, show that the former come together at a less angle, and are therefore more oblique. The anterior marginal scute is, as in Chelone, present and not confluent with the first vertebral as in O. platylomus. Both the first and second marginal bones are entirely united with the carapace: in the O. platylomus but the inner half of the second. The anterior vertebral bone widens within the margin as in other species, but it is the first costal which completes the consolidation of the carapace anteriorly. Both second and first marginal bones are slightly concave along the outer face; both are convex or plane in the species before described.

The third and fourth marginal bones, while of the same length as those of O. emarginatus, are half as wide again, a form produced by the projection inwards of the lower face. The fifth presents the same peculiarity in a more marked degree, and has a thicker outer margin or is more rounded from below. The fossa for the rib is less than .2 the length of the bone, while the same in O. emarginatus is .33 the length. The seventh marginal has the prominent inner lower edge, but is more elevated than the same in the species last described. Its superior surface is therefore considerably more concave. The most posterior marginals, as characteristic of the genus, are prolonged considerably within the inner suture of the marginal scuta. They are quite flat, plane above, and with a rounded concavity beneath within the margin; the rib pit is flattened in these. The dermal suture crosses the marginal bones in all the marginals from the fifth backwards inclusive just in front of the costal pit. A hyosternal, a hyposternal, and two xiphisternal bones are all that remain of the sternum. They are of much the same form as those of O. emarginatus. The hyposternal has the external groove posteriorly to receive the xiphisternal, while the episternals have a groove internally to receive the hyosternals. The xiphisternals are toothed on their inner margin for common suture which is not so long as in O. emarginatus. The xiphisternals have evidently been shorter and more broadly rounded behind than in that species. They have not the same thin acute external margin proximally nor strong intermarginal thickening distally seen in the same, but are of more uniform proportions. The hyosternal preserved is the distal portion, while that of O. emarginatus is chiefly proximal. It is however obviously a thinner plate than in the latter, and more as in Propleura sopita. The anterior margin preserved is that between the episternal and axillary portions; it is regularly thinned out; the distal part of the bone is flat, and the median suture toothed. A short free margin indicates a mesosternal fontanelle. Median and posterior fontanelles also present.

Measurements.	*In.*	*Lin.*
Length second marginal,	3	0.75
Width " " (external)	2	4.
Length fifth "	2	11.
Width " " (below)	2	
Length seventh "	3	2.
Width " " (below)	2	8.
Length tenth "	3	3.
Width " " (external)	3	10.5
Length of a vertebral bone,	2	5.
Width " " "	1	9.5
From end of xiphisternal notch to anterior margin of hyposternal,	2	6.
Greatest width episternal,	2	4.5

Portions of another individual from Barnesboro, confirm the characters already given, and indicate the largest of the group known by the shell alone.

The remains are the first and eleventh marginal bones of the right side, and the fifth of the left, with the nuchal and numerous costals, including the humeral or first costal. Also several vertebral bones, with parts of the sternum, the scapula, coracoid, femora, etc.

The marginals exhibit the characters of the genus, the eleventh particularly, which is wanting in the first specimen, exhibiting a suture for union with pygal bone. It is therefore produced much beyond the suture of the marginal scuta, a peculiarity not existing in any species of Propleura. The same bone is relatively considerably stouter than in P. sopita. The first marginal is deeper and shorter than in the same, and the fifth differs in the same way, and is much wider as well. The nuchal is concave and arched medially, and bears a well marked marginal scutum. The adjacent scutum on each side is relatively shorter than any of the others, and has an oblique inner suture.

The vertebral bones are narrower than in the O. platylomus and are elongate oval in outline behind. They present superiorly a shallow longitudinal groove interrupted at the middle of the length.

The scapula presents a short coracoid articular surface. The procoracoid is flattened in the plane of the scapula.

The femur presents the usual constricted cylindric shaft, with trochanters whose planes include an angle a little less than 90°.

	In.	Lin.
Length of eleventh marginal,	3	6.5
Width " "	4	.3
Width of a costal,	3	2.
" " first marginal,		22.5
Length " "	2	7.
" nuchal bone,	5	
" vertebral,	2	3.
Width "		15.5
Diameter shaft of femur,		7.3

OSTEOPYGIS CHELYDRINUS, *Cope*, *Sp. nov.*

This large and most distinct species was found in the same locality as the preceding. It is unfortunately only represented by ten marginal plates more or less perfect, and portions of some costals, but these are sufficient to indicate some of its peculiarities. It combines more of the peculiarities of Chelydra in these pieces, as Euclastes does in the physiognomy of its cranium.

The marginal bones are relatively much shorter than in any of the other species. It is however referred to this genus with certainty since the anterior rib-bearing marginal bone has been united with the middle disc by suture, and some of those posterior are ossified within the common margin of the costal and marginal scuta. The outer margin of these and of the median bones of the series, is very heavy, but little produced, but projecting from a concave upper face. The inferior faces of the posterior median are convex and produced inwards further than usual, and joins the inner face by an obtuse angle. The rib-pits extend deeply, or to within a short distance of the surface.

One posterior marginal is thicker than in O. emarginatus and has a convex inferior face. The upper margin of the inner face is prolonged above the lower. The rib-pit is round; the dermal suture well marked. On this bone the character of the posterior outline is marked. The anterior half of the margin is quite concave, leaving a strong and prominent angle at the extremity of the dermal suture. This is much stronger than those seen in Catapleura repanda, though the bone described is more posterior than those of the latter.

The surface of the posterior bone has some faint vascular grooves; the others are without them, but are of a coarse texture.

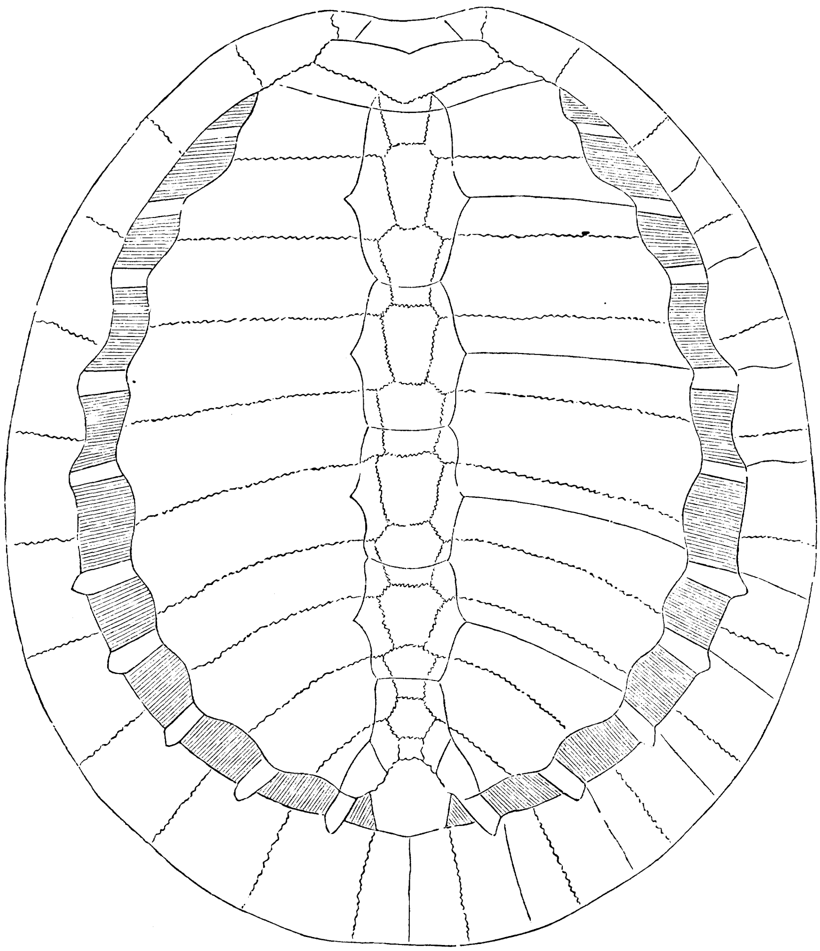
Measurements.	In	Lin.
Length posterior marginal,	2	9.3
Width " "	3	2.
Depth " " within,		9.5
Width lower face middle marginal,	1	7.7
Length anterior united marginal,	2	6.
Width " " "	1	9.
Width dermal scute on same,	1	?.8
Thickness costal bone,		4.

PROPLEURA, *Cope*.

This genus of Chelydrinae is intermediate between Osteopygis and Lytoloma, presenting more characters of the former than of the latter, so far as regards the carapace. The marginal bones are free behind, except probably that the median is attached to the posterior supernumerary vertebral (this piece is lost in my specimens); and the series of marginal dermal scuta are connected by a median marginal cut off from the anterior

vertebral, as in Chelone. This occurs in Osteopygis. The anterior connection between the carapacial disc and margin is more as in Osteopygis. The first marginal has a weak connection with the disc, but is almost free posteriorly; the edge of the second marginal is broken, but I have doubts whether it was attached as in the known species of Osteopygis by the margin; it was supported by a strong rib as in that genus, a point in which both differ from Chelone.

Fig. 39.



Carapace of Propleura Sopita, restored.

The femur has the slender shank of Osteopygis; the humerus is broad and stout.

I. Margins of posterior marginals regular or convex.

Upper and lower inner margins of 8th marginal bone equal, with cylindric fossa, width $\frac{8}{9}$ the length—that is much longer than in the O. platylomus: vertebral scuta elongate, little dilated at lateral angles; width 5th marginal bone little over .6 the length.

SOPITA.

The accompanying cut is a restoration of the typical species of the genus, and may be compared with those of the genera preceding and following. Like the others, it is derived from a great number of broken fragments which have been arranged and attached. On one side the dermal sutures have been omitted for clearness sake.

The structure of the sternum appears to be identical with that of Osteopygis.

It may be added that the genus Euclastes, Cope, was established on the cranium of a turtle, which will perhaps be found to enter either this genus or Osteopygis, in either of which cases it will have priority of publication.

PROPLEURA SOPITA, *Leidy*.

Chelone sopita, Leidy, Cretac. Rept. N. Amer. Smiths. contr. xii., 104. *Osteopygis s.*, Cope, Pr. A. N. S., Phila., 1868, 147.

This species is indicated by two marginal bones, part of a costal, half a femur, a tarsal and two phalanges, which lay in close proximity in a block of the Timber creek Limestone taken from the quarry of Barclay Edwards, near Harrisonville, Salem county, N. J. The original specimen, several marginal bones of one individual, are in the State Collection of New Jersey, while the specimens also described and figured by Leidy in the Cretaceous Reptiles, I can scarcely refer to the same species.

The principal evidence, however, on which this species rests, is a partially complete carapace and plastron, with some limb bones from the marl excavations at Birmingham, N. J.; and for which the Academy of Natural Sciences is indebted to Judson Gaskill, one of the proprietors. The portions preserved are the first, third, fourth, seventh to caudal marginal bones of one or both sides; the front vertebral, with numerous costals and the hyo- hypo, and fragments of epi- and xiphisternal elements.

The specimen is of about the same size as that on which Osteopygis emarginatus, from the same place is chiefly based, and the anterior marginal bones are similar in proportions to those of the latter, and not so broad in relation to their length as in O. platylomus. In some other respects it approaches nearer the otter, which seems to stand rather between it and the O. emarginatus.

The front marginals are of about the same length as those of the O. platylomus, but are very much thinner and lighter. The external margin of the first is convex and continuous, with a marked concavity of the nuchal bone, which is slighter in O. platylomus, and is wanting in O. emarginatus. The posterior part of the first is of increased thickness, while the second is still more rapidly heavier. They have no groove on the inner inferior edge, but a wide, shallow one externally. This is weak on the third; the external face of the fourth exhibits a slight continuation of it; the same face of the fifth is regularly concave. The superior face of the seventh is gently concave, and the inferior more strongly convex. The edge of the eighth is slightly everted, while the more posterior are flat. The rib-pits are round conic, those from the ninth posteriorly not completed above, from the thinness of the bones. The edges of the posterior bones are not prolonged within that dermal sutural groove. The intermarginal dermal grooves are more indistinct in this species than in others, or at least are so in the three specimens I have seen. The costo-marginal suture is not visible either on the fourth or any more anterior marginal bone.

			In	*Lin.*
Length of edge of nuchal marginal,			4	6
Length of first marginal.			2	9.6
Width of "	"		1	9.6
Width of fourth	"	above (greatest)	2	
Width of "	"	below (median)	1	2.5
Length of "	"		2	11.2

			In.	*Lin.*
Length of seventh marginal,			3	1.4
Thickness of "	"	posteriorly		11.5
Width of "	"	below	2	2.5
Width of eleventh	"	above	3	6
Length of "	"	(median)	3	3

Large portions of many costal bones are preserved. These show the ossification to have been more extensive than in the species of Chelone. Their thickness is more uniform than in some species. The capitula of the ribs are round, and are on subcylindric bases. The anterior is peculiar for its flattened form ; on its anterior margin is a broad rugose band, which contracts into a groove on the side of the capitular process. The dermal sutures are quite distinct. The vertebral scuta are longer than wide, with bracket-shaped lateral sutures, little prolonged at the angles. One of the transverse intervertebral sutures is strongly concave, probably backward. Where the capitulum springs from the inferior surface of the costal bone, there are usually six, or more or less, radiating short grooves, pointing towards it as a centre.

	In.	*Lin.*
Width of costal bone,	1	7.2
Thickness " " on margin,		3
Length poster half lateral suture vertebral scute,	2	2
Width vertebral scute on costal bone (greatest)	2	4

Large portions of both *hyosternals* and both hyposternals are preserved, with fragments of an epi- and xiphisternal. The inguinal margin is strongly curved and thickened ; its median portion is concave, with a sharp margin below. The axillary thinned medially and inwardly, and thickened outwardly. The hyposternals are also thinned towards the hyosternals. The episternal is acuminate posteriorly, and steeply bevelled on the outer margin. The xiphisternal is attached as in osteopygis, by a groove on its inner face, embracing the margin of the hyosternal. This groove is, relatively, considerably shorter than in the two species of that genus known. The proportions of the bone are narrower than in them ; the edge is thin, and the surface rises abruptly from it over a thickening which does not appear in either of the before mentioned species. The external sutural process is also more posterior. The margin of the hyosternals is thinner than in O. emarginatus, and they thicken inwardly as well as outwardly ; they only thicken outwardly in O. platylomus.

	Lin.
Width hyosternal,	24.5
Thickness inguinal margin hyposternal,	5.8
Width xiphisternal (cross axis) at end inner hyposternal groove,	19
Width episternal two inches from proximal end,	14.5

A perfect *femur*, and a humerus with the head injured, were procured with the other bones. The former is characterized by its slender shaft, the great antero-posterior extent of its united head and great trochanter, and the large transverse extent of the condyles. In general form it is much more like Chelys than Chelone, though in the points mentioned it exceeds the former. The articular surface of the head is very convex, and is prolonged in a narrow band along the summit of the great trochanter. The little trochanter stands nearly at right angles to the first. The shaft is sub-round medially. Compared with the femur described under Taphrosphys molops, but which may belong to Propleura augusta, the inner tubercle is not so prominent and acute, and the posterior projections of the condyles are not so strong. The head of the uncertain femur is not projected so far forwards, and is much more convex ; the great trochanter is not continuous with it, hence the articular surface is not prolonged.

	In.	*Lin.*
Length of femur,	5	3
Width of head and trochanter,		22
Width of condyles,		18

The *humerus* is curved like the femur, but is flatter and broader as compared with the other dimensions. The shank is flattened, and the condyles relatively less dilated transversely than those of the femur. Inside the inner distal margin is a deep open groove, for the passage of the humeral artery. The coracoid has a constricted shaft; its clavicular articular face is short, and the suture smooth. In Trionyx, the latter is longer and interlocking.

	In.
Estimated length carapace,	26
Estimated width "	24

The following characters are observed in the Harrisonville specimen :

The species differs from the Osteopyges in its relatively wider posterior marginal plate, with very indistinct dermal sutures ; though the surface is fully preserved and the vascular grooves distinct, these are very faint. The costal pit is less flattened, and the inner margins of the plate are equal, the upper being less prolonged. The anterior marginal differs from the same in O. *emarginatus*, in lacking an open groove within the lower margin. The form of the femur has been noticed in the remarks on the genus. It is considerably curved, and with a slender shaft. The inner condyle is the larger, and within it is a compressed longitudinal ridge. Surface striate with small ridges.

Edge of the posterior marginal bone slightly recurved.

	In.	*Lin.*
Length eighth marginal,	3	7.5
Width " "	3	1.5
Depth " " at rib pit,		11.5
" last anter. marginal with rib at margin,		9.5
Width condyles femur,	1	9.7
Diameter shaft near middle,		8.5
Length phalange,	1	1

The Euclastes *platyops*, *Cope*, is only known from a cranium found in the same limestone. The present species bears some nearer relation to that in dimensions than any known.

A very large specimen of this species was presented to the author by John Miers, who procured it from his pit near Hornerstown, from the upper cretaceous green sand. Its dimensions exceed those of any of the other Chelydrinae, yet they present the incomplete extension of the union of the marginal and carapacial bones characteristic of the genus.

	In.	*Lin.*
Length of ninth marginal	4	4
Width,	3	6
Depth (medially within),	1	2
Length tenth marginal,	4	1
Width,	4	1

These marginals are opened by *l. l. c.* marginate at the end of the inter-marginal scutal sutures. The measurements of the proximal extremity of the humerus give further indication of its proportions.

	In.	*Lin.*
Length of the condyle and deltoid ridge,	2	9
" " " alone,	1	4.5
" " postero-interior crest,	1	

CATAPLEURA, *Cope.*

In this genus, as in the two preceding, the carapacial disc is united by suture to two marginal bones, on each side of the nuchal bone, forming a solid arch. What the mode of attachment between the two may be posteriorly, material is not sufficient to determine; but from the form of some tenth and ninth marginals, I suspect that this union is not so great as in Osteopygis, but rather as in Propleura, by the caudal marginal only. There is a nuchal scutum, as in the last genus. What distinguishes it from that genus, as well as from Osteopygis, is the entire absence of the rib and pit articulation between the second marginal and the corresponding costal bones. It is in this respect similar to Chelydra, and to Chelone, counting one rib less than in Propleura. From the similarity in thickness and form of the first marginal, I suppose the genus Lytoloma to have been similar to the present, in this respect, and a supposed second marginal confirms the view.

The only species of this genus yet known is peculiar in the form of the nuchal marginal. It is not wider than the first and second marginals, and does not, therefore, extend over the front of the carapace, as in Osteopygis, Chelydra and Chelone. It is intermediate in extent in Propleura sopita, while it is identical in form in the Lytoloma jeanesii. The natural position of the type species is, therefore, plain enough. In the present genus and Propleura the form of this piece is perhaps of not more than specific value.

I. The margins of the posterior marginal plates repand or concave.

Posterior lateral bones, with upper margin produced within, narrow; width 6-7ths length, margin openly repand; anterior marginal scuta $2\frac{2}{3}$ long as wide, many of these bones confluent with disc, none concave on outer surface.

C. REPANDA.

CATAPLEURA REPANDA, *Cope.*

Osteopygis repandus, Cope, Proc. A. N. Sci., Phila., 1868, p. 147.

This species is based on remains of one individual, which is represented by parts or wholes of ten marginal and of many costal plates. Its size is smaller than the preceding species, and it is further characterized by the repand outline of the posterior marginals with obtuse points at the dermal sutures. The middle marginals are concave instead of convex below, as in O. emarginatus. The narrow anterior marginals are convex on the outer surface, and bear very elongate scutes, which are narrower than in any other species. Five of these marginal bones have been united above by suture to vertebral or costal plates, indicating the same degree of ossification as in O. emarginatus. The dermal sutures are less marked than in that species, but are indistinct, as in P. sopita. On two costal plates, the margins of these are distinct. They are straight, make open angles with the transverse grooves, and with each other, and indicate scutes longer than broad. The costal bones are plane, longitudinally, but considerably decurved from and below the middle. The costal ridge is distinct throughout, and narrow, and extends obliquely to the posterior suture, and then projects shortly for attachment to the marginal bone. The costal heads present at their posterior bases an acute ridge, which diverges posteriorly, embracing a strong groove between it and the body of the rib: both extend but a short distance posteriorly. I have not seen this feature in the ribs of the O. emarginatus, and O. platylomus.

The vascular grooves are quite distinct, forming short, straight and zigzag, sometimes crossing grooves. In the posterior or wider marginals, the upper inner margin is produced inwards above the lower. The rib pits are round. None of the marginal bones have recurved edges.

Measurements.	*In.*	*Lin.*
Width of a posterior marginal,	2	1.5
Depth " " " within,	1	
Depth " an anterior " at edge,		7
Length " " "	2	4.5
Width " " "	1	9
Width of dermal scute on same,		9
Width of middle marginal, above	1	9
Width " " below	1	
Length of costal bone on curve,	5	
Width " " "	1	11
Thickness of costal bone at middle margin,		2.5

The specimens on which this species are based were obtained from the pits of the West Jersey Marl Company, near Barnesboro, Gloucester county, New Jersey, and were presented to the author by I. C. Voorhees, Superintendent there.

LYTOLOMA, *Cope.*

This genus is more like Chelone than any of the Chelydrine forms here described. The characters are derived solely from portions of the carapace which are preserved, and are as follows:

The marginal bones free from the carapace except at the anterior and posterior portions, narrow anteriorly, expanded behind.

The evidence for these characters consists: first, of a median and a first marginal bone of a species from the green sand of Barnesboro; second, of two marginals and a mandibular arch from Birmingham; third, of four consecutive posterior marginals from Mullica Hill; fourth, of parts of a skeleton from Hornerstown. The first represents the Chelonioid freedom of all but the nuchal marginal plate, in front, by the entirety of the margins of the first. The second presents a free anterior marginal, and a narrow middle marginal with rib pit. The third probably belonged to the same species as the last, and presents in the inner margins an absence of the disposition to expansion, which exists in the genus Osteopygis, where the union of disc and marginals is extensive. It appears to have been similar to the genus Propleura in the posterior part of the carapace.

Two species of the genus appear to be indicated by the material at my disposal, which can be thus distinguished.

The anterior (first and probably second) marginals with entire convex margin.

L. JEANESII.

The anterior (second and probably first) marginals with openly emarginate margin.

P. ANGUSTA.

LYTOLOMA JEANESII, *Cope, Spec. Nov.*

This turtle is known by two marginal bones, the nuchal with its suture for the first vertebral distinct, and the first with the usual divergent suture for union with the nuchal. A second specimen, which I owe to the liberality of John Meirs, was taken from the lower part of the upper Greensand bed at Hornerstown, Monmouth county, N. J.

It shows its relationship to the Catapleura repanda in the narrow proportions of the nuchal bone, which thus resembles an ordinary marginal, and differs entirely from the form in Chelydra and Chelone. Another point of similarity is the union of this bone with the first marginal by a coarse gomphosis, the process pertaining to the latter.

Its marked peculiarity is the normally narrow and free first, and therefore second marginal bones. The first gradually narrows inwardly, and is bordered by a regular, slightly concave, free margin. Its suture with the nuchal is straight: its suture with the second has the entering angle near the outer margin seen in C. repanda, P. sopita, etc. The rounded margin of the nuchal is not heavy; that of the first marginal is more so than in C. repanda, and increases near the posterior suture.

An indistinct scutal suture crosses the middle of the marginal; but whether the marginal scuta are narrower than the bone, cannot be determined. The line separating the first vertebral from the nuchal descends, or narrows the nuchal scutum, but not so rapidly as in C. repanda, being straight instead of concave.

The first marginal bone is three-fifths as wide as long in the present species; in the C. repanda four-fifths as wide as long.

	Lines.
Width nuchal marginal,	16.5
Width " scutum,	8.5
Width first marginal,	15.5

The Hornerstown specimen furnishes portions of several costals, and three marginals, with the head of the humerus. They were taken by the writer from the green sand, in natural relation; they indicate an animal of as large size as the Osteopygis emarginatus, and demonstrate that the characters on which this genus rests, although those of immature Osteopyges, are nevertheless those of adult animals.

The superior margin of the first marginal is entire, and rather thin, showing its complete separation from the carapacial disc. The outer margin is somewhat thickened, and the proximal extremity exhibits the usual wedge-shaped articulation. Length exteriorly, $3\frac{3}{8}$ in.; width, 1 in. 5 l. A lateral marginal, perhaps the sixth, is remarkable for its narrow form, and the nearly equal measurements of the three chords of its transverse section. The external face is thus very oblique and the margin not at all recurved, or in any way emarginate. The rib pit is round conic. Length, 3 in. 9 l.; external face, 1 in. 6 lin. wide; internal chord, 1 in. 5 l. The inferior and superior inner margins are alike thin and acute. Width of a costal bone, 3 in. 6 lin; depth near sutural margin, 3 lines. Diameter humeral condyle, 1 in. 6 lin. The costal bones are without sculpture.

Discovered in the upper green sand-bed or the upper Cretaceous, near Barnesboro, Gloucester Co., and Hornerstown, Monmouth Co., N. J.

This species is named after Joseph Jeanes, of this city, an active and liberal member of the Academy of Natural Sciences of Philadelphia.

LYTOLOMA ANGUSTA, *Cope.*

Chelone sopita, Leidy. Cretac. Rept. U. S. Smithsonian Contrib., XII., p. 105 (Second Specimen), Tab. XIX., fig. 2.

Posterior and lateral marginal bones, with the upper margins, not produced beyond the lower. The second with a deep, open emargination, the length twice the average breadth. Width of fifth .5 length, the superior surface concave; vertebral scuta wide, angles produced.

This species is at present indicated by a mandible and some marginal and costal bones. These are, however, so characteristic and different from anything hitherto observed in the Cretaceous Green Sand of New Jersey as to de-

mand record. Its form suggests the same portion of the Thalassochelys planimentum and Th. crassicostatus of Owen (*Chelone* Ow.) from the Eocene of England; but it is much more obtuse, and broader, in relation to its length, than either of these. As the extent of the symphysis among Testudinata bears some relation to the position of the posterior opening of the nares, the pertinence of this jaw to the Euclastes platyops suggests itself. Its flatness and shallowness, and want of recurved alveolar margins, are appropriate to the shallowness and small alveolar margin of the maxillo-palatine face. There is, however, no trace of that elevation and acumination of the extremity of the symphysis, associated with the premaxillary concavity and foramen to the nasal meatus, which is to be looked for, and which occurs to some extent even where the foramen is wanting, *e. g.*, in the Thalassochelys caouana. In its specific features, it is different from the E. platyops in its greater abbreviation. In the former, the width at the anterior margins of the coronoid process is to the median length anterior to the line between these points, as 2:4-5; in the latter, measuring on the cranium below, as 2:1 3-5.

In this species the posterior margin of the symphysis is opposite the anterior part of the coronoid bone; the anterior margin of the coronoid elevation of the dentale measures the posterior or third of the symphysis. The sutures of the dentale with other elements nowhere consolidated. The internal groove passes round the hinder face of the arch, situated deeply between the prolongations of the superior and inferior plates. Mandible beneath, flat, abruptly rising to the alveolar ridge. This is broken away, but from fragments of surface remaining, has been but little elevated. Superior alveolar faces, nearly plane, slightly elevated longitudinally on the median line, where the surface is slightly striate. Portions of the superficial plate remaining offer no evidence of an upward curvature, though a small portion of the extremity has been worn off.

A striking feature in this species is the size and depth of the fossa for the insertion of the masseter muscle. It is relatively greater than in any of the recent Chelonidæ which I have seen, and indicates great muscular power. This necessitates the shortness of the mandible, as it is less strengthened in the vertical direction than the modern species. The mental foramen enters in the anterior portion of this fossa. The dental foramen, of equal size, enters below the middle of the coronoid bone. The wall of the fossa is the inferior plate of the mentum prolonged into a strong ridge.

Measurements.	*Lines.*
Length of symphyseal line,	25
Width at anterior margins, coronoid processes,	42.7
" apices coronoid bones,	42.7
Elevation apices coronoid bones,	19
Depth at symphysis behind,	8

Two portions of peculiar marginal bones, from the left side of the carapace of one of the Cheloniidae, found at the same time and place as preceding, have much the same mineral character, and probably belong to it. The piece from the median margin is quite thick on the inner face, which, with the upper face, is concave; lower, slightly convex.

	Lines.
Depth within,	10.5
Width below,	15.5
Width above,	12.5

Fossa for costal extremity, open conic.

A portion of what is perhaps a fourth left marginal, is triangular in section, each side concave, the inner face most extensive. The margin is obtuse, and presents an open concavity, thus connecting the forms of the second and fifth bones here described.

Width of inferior margin, 9.5 *lines*.

Second marginal very shallow, vertically; a very open emargination between dermal shields, which have left a shallow sutural groove. It presents a narrow truncate inner margin, and there is no rib-pit in it.

	Lines.
Depth within (distally),	7.
Greatest width,	16.5
Width at emargination,	13.5

A costal bone of the right side, with its external portion broken away, accompanied the above, but probably does not belong to the same species. It is thin, and the head of the rib is almost cylindric. The surface is marked with delicate vascular grooves, which are largely parallel to each other. The external angle of a vertebral scute falls near the posterior border 2.3 inches from the vertebral suture, indicating considerable breadth. The angle is right. The anterior outer suture is slightly concave, and begins to assume a nearly longitudinal direction on the costal suture, one inch from the vertebral.

	Lines.
Width of bone,	23.5
Thickness at lateral suture,	2.5
Longer vertebral suture,	14

The specimen indicating this species was found near Pemberton, Burlington Co., N. J., and was presented to the Museum of the Academy by Dr. Samuel Ashhurst. At the same time and place were found plates and a broken femur of correlative size of a large individual of Prochonias sulcatus; the latter measured 18 lines across head, and 16 across condyles. There were also remains of Adocus, Hyposaurus, Holops, and Mosasaurus.

Prof. Leidy describes (Cretaceous Reptiles) two species of Marine Turtles—Chelone sopita, and Chelone ornata. There is no evidence that the mandible herein described pertained to either of these species, and the identification of the accompanying marginal bones indicates a considerable difference. These are in the present species concave below, in the P. sopita convex or plane. In L. angusta the suture of the dermal scutes marks an entrant angle; in the P. sopita, a projecting one. The same bones are relatively narrower than in any of the species of Osteopygis, and have planer margins, and round pits. Their narrowness suggests that the extremital marginals may have been still less united with the disc than in the species of Propleura.

This species is also known from the three marginal bones, and part of a fourth, described and figured by Dr. Leidy, as above. I suppose them to be from the sixth to the ninth of the left side, inclusive. The animal has suffered an injury, as a deep notch is cut in the margin between the eighth and ninth, and another just behind the rib-pit of the ninth.

The species differs markedly from the P. sopita in the flatness and slenderness of the more lateral marginal bones, and were it not for the posterior marginal of the P. angusta preserved, might be referred to that tortoise. The inner edge of the seventh is not so deep as in the P. sopita, and the breadth relatively less; the same is true of the sixth. The superior edge is prolonged but little beyond the inferior. The pits for the costal pegs are behind the line of the posterior two-fifths of the length, on all the bones. Pits round conic, inner edges equal. Margin from seventh slightly curved up.

	Lines.
Width sixth,	18
Depth " on inner border,	10.5
" seventh " "	9
Length " " "	31.5
Width " (average,	20.5
Width of eighth, $\frac{7}{8}$ the length.	

From the upper Cretaceous Green Sand Bed, Mullica Hill, Gloucester Co., N. J.

EUCLASTES.

Cope, Proceedings Academy Nat. Sciences, 1867, p. 39.

This genus was established on a species, represented by a single imperfect cranium, procured by Thomas Heritage from his marl excavations, near Hurfftown, in Camden Co., N. J. The matrix in which it is preserved is very similar to that near Vincentown, in which the cranium of the Thoracosaurus neocaesariensis was discovered, being a coarse, granular limestone.

The physiognomy of this large turtle in the obliquely expanded zygomata and short muzzle is like the Pleurodire genera Podocnemis Wagl. among recent Chelonia, and Bothremys Leidy, of the same age, among extinct forms. Its completely over-arching temporal fossae add to the impression of its affinity to the former genus, but on inspection of the vomer, it is found to be as in the true Cheloniidae, largely developed on the palatal surface between the *o. o.* maxillaria, and to extend to a posteriorly situated nareal opening. Though this element is unossified in the Chelonioid types of Pleurodira, Peltocephalus and Podocnemis, it is well developed in the family Chelydidae, (Agassiz) and the peculiarity of the cretaceous species might still exist in this suborder. As it is a matter of much interest to determine the precedence in time of the two suborders of the Chelonians, I have taken pains to remove the matrix from the orbital and nasal cavities, so as to determine the structure of the pre-frontal bone. As I have elsewhere pointed out, this sends downward a column to the vomer, either vertically or directed obliquely inwards, in all the Cryptodira, while in the Pleurodira the column is wanting.

The diagnosis will be as follows: That of the Bothremys a Hydraspid, which has furnished the only other cranium from the same formation, is introduced. It also has the vomer osseous extensively in contact with the maxillaries on the palatine surface.

BOTHREMYS, *Leidy*.

Posterior nares separating vomer from *o. o.* palatina; premaxillary margin concave, involute; alveolar profoundly concave, vomerine surface a sulcus; nasal meatus floored in front.

EUCLASTES, *Cope*.

Maxillaries and palatines separated throughout by the prolonged vomer; posterior nares opposite palatal front margin of orbits; premaxillary margin projecting beak-like; alveolar face little concave, vomer forming a central ridge. Floor of nasal meatus perforate for hook of mandible.

While Bothremys had an inferior mouth and projecting muzzle, as in the modern Hydraspides, the nostrils of the Euclastes were superior and behind the short projecting beak. The orbits are not, as in the Macrochelys of the Mississippi, far anterior and reduced in

size; but their centres are distant from the end of the muzzle (measured axially) more than one-third the total length of the cranium.

The descending portion of the pre-frontal is very wide, and equal to the width of the maxillary outside the lachrymal foramen; the latter is small. Internally, the columns of the prefrontals converge below to nearly an acute angle, and are directed forwards along the vomer. They restrict the nasal meatus extensively, leaving its diameter less than that of the columns. On the muzzle the pre-frontals have but a short common suture, admitting the frontal far between them. The internal nostrils have a diameter each side the septum equal to that between the pre-frontals.

EUCLASTES PLATYOPS, *Cope.*

Premaxillaries narrow, rounded in front; maxillary outline, nearly straight to below anterior rim of orbits, where the breadth of the muzzle is 4 inches, length to end of muzzle only 2. Plane from top of prefrontals to maxillary margin straight, oblique maxillary margin with a gentle sigmoid flexure; Squamosal much expanded below and behind orbits. Frontal region flat, parietal rising behind; nasal meatus subquadrate, slightly narrowed below, its palatal foramen with a free lateral osseous margin. Alveolar ridge divergent, little projecting above the oblique surface; the latter is most concave behind on each side of the vomer, presents no ridges, and few nutritious foramina. Line of common suture of o. o. maxillaria in front of vomer, in a sulcus. Palatines cuneiform with everted margins posteriorly, latter most elevated on each side the small choanal opening, which is bounded in front by the projecting posterior knob of the vomer. The maxillaries are very massive, and underlie more than two-thirds the area of the orbits; they receive a very extensive descending portion of the prefrontals, their union extending so far towards the median line as to leave but a narrow nasal meatus. This offers a powerful resistant face to the motion of the mandibles. The posterior orbital margin is .75 inch in thickness, and is at right angles to its alveolar margin. Pterygoids almost entirely broken away. The following measurements will furnish the best data for a comprehension of the form in detail.

	In.	*Lin.*
Total length cranium,	11	
Breadth behind orbits,	8	6.
" between poster. margins orbits,	5	2.5
Least interorbital width,	2	2.5
Width of nasal meatus,	1	2.5
Depth premaxillaries,	1	1.
" maxillary at middle orbit,	1	3.5
" squamosal at zygomatic arch,	2	2.
Length naso-prefrontals,	2	3.
" " " common suture,		6.2
" common suture frontals,	2	4.
" from anterior margin orbit to nasal meatus,		11.
" " premaxillary margin to end vomer,	3	9.
Width posterior nares together,	1	1.5
" palatine bone opposite end of vomer,		.9
" vomer near anterior extremity,		.7
Greatest diameter of orbit,	2	.6
Least " "	2	

The broad, regular alveolar surfaces have no doubt supported a massive corneous table, in some degree like that of Platypeltis ferox, and with little or no external cutting margin. This arrangement, as well as the compactness of structure, are appropriate to a nutrition dependent on crushing more or less hard bodies, as molluscus. That the Ostreae, Terebratulae, etc., of the sea coasts or estuaries in which it lived formed much of its food, is therefore quite probable.

Estimating the proportions to have been similar to those of Chelydra serpentina,* the dimensions of the Euclastes platyops were——

	Ft.	*In.*
Length from end muzzle to end tail,	6	10.
" of carapace,	2	8.5

This species belongs most probably to one of the genera of the same type here described, but whether to Peritresius, Propleura or Osteopygis, is not as yet ascertainable. In any case, Euclastes is an older name than either of the above.

PERITRESIUS, *Cope.*

This genus is proposed to express the characters of the Chelone ornata of Leidy. Nothing is known of the species but a costal and parts of two adjacent marginal bones. These are covered with coarse tubercles, as in some Trionyx, and more as in Prochonias nodosus. There are no dermal sutures on the specimens, and it is not probable that the dermal covering was corneous or scutiform. The pit for the rib is very small and flat, and not at all as in Chelone. Were it not that the head of the rib is not so flattened as in Trionychidae, I should imagine the genus might be allied to Emyda, or the Trionyches, with marginal bones. With our present knowledge, it is better that the costal bone should remain near Peritresius.

The structure of the costal bone above the inferior or costal layers is vesicular. The entire freedom of the marginal bone separates the form from any of our known Pleurodira.

PERITRESIUS ORNATUS, *Leidy.*

Chelone ornata, Leidy, Proc. A. N. Sci., 1856, 303 Cretaceous Rept., l. c.

Marginal bones, covered with coarse tubercles in the middle, and coarse ridges near the sutures, which are wider than the intervals between them.

New Jersey.

TRIONYCHIDAE.

Seven species of this family have been found in the North American strata, all referable to

* Compared inappositely with *Hydraspis maximiliani* in the original description.

TRIONYX, *Geoffr.*

Costal bone transversely figured by narrow elevated ridges. T. LIMA.

Costal bone with thick, low transverse ridges, which are connected by cross-ribs, which leave series of pits.

T. PRISCUS.

Costal bones with transverse irregular grooves proximally, which remain along the suture only distally, leaving a triangular area of a shallow honey-comb pattern medially.

Large, massive; the grooves of the shell widens the intervening ridges.

T. PENNATUS.

Smaller, light; the grooves much wider than the fine separating ridges.

T. BUIEI.

Costal bones, with a shallow, coarse honey-comb pattern, tending to confluence distally.

The vertebral segments shorter and wider; shell heavy, much arched.

T. HALOPHILUS.

The vertebral segments of the carapace long and narrow; shell thinner, flat.

T. GUTTATUS.

TRIONYX HALOPHILUS, *Cope.*

Proc. A. N. Sci., Phila., 1869, p. 12.

Established upon numerous portions of vertebral sternal and costal plates, from near Summit Bridge, Newcastle Co., Delaware, and from Camden Co., New Jersey; both from the lower bed of marl, according to Cook's explanation of the Cretaceous period.

This species differs from the Trionyx priscus Leidy, in the character of its sculpture. It is pitted coarsely and regularly, five to six in an inch on a costal or vertebral plate. In the Tr. priscus the pits are considerably smaller, and disposed in series across the costal plates, which are separated by ridges stronger and more elevated than those that separate the pits themselves. The same arrangement is visible on a portion of a xiphisternal bone, from green sand, near Petersburg, Va., in the collection of John S. Haines, member of the Academy, with portions of costal plates, all referable to the Tr. priscus. The specimen described by Leidy was from Monmouth Co., N. J. The confluence of several of the pits produces a somewhat similar appearance, as is common among Trionyches, on the outer margin of the second costal plate from the front on the left side, and probably on the extremities of the other plates, none of which are preserved. On a portion of a sternal plate, probably xiphisternal, the pits are equal and regularly distributed, but much smaller than on a costal, to the number of ten in an inch.

One costal bears a portion of the head of the rib; one vertebral a nearly complete centrum and neural arch, and another, pleurapophyses. Of a perfect vertebral plate the length and width are equal; the anterior suture concave, the posterior convex. The costal segments are markedly curved. The following measurements will furnish further characters.

	Lin.
Length of vertebral plate,	16.25
" anterior suture plate,	7.5
" " lateral suture plate,	7.25
" posterior " " "	11.
" " suture,	10.
Diameter of neural canal,	2.25
Length of centrum vertebra, No. 2,	13.75
Width " behind diapophyses,	7.
" " at "	12.
Depth " with plate, anteriorly,	12.
Width of costal plate No. 1,	17.
" head of rib on No. 1 at origin,	7.
Width costal plate, No. 3,	21.25
" " " 5,	25.5
Thickness of costal plate at 28.25 lines from prox. suture,	4.5
" second plate at rib on outer margin,	6.25
" vertebral plate near margin,	3.75

The costal plate of Trionyx, mentioned by Leidy (Cretaceous Reptiles, 113), from Burlington Co., N. J., probably pertains to the same species. Besides the localities above alluded to for the Tr. priscus, Leidy records a probably third cretaceous species from the Mississippi. The marine habitat of some of these species becomes quite probable, for both individuals and species are perhaps too numerous for all to have wandered from the mouths of rivers. We have the authority of Duchaillu for the statement that the Aspidonectes aspilus is found occasionally at sea, outside the mouths of the rivers, where it occurs in tropical western Africa.

TRIONYX GUTTATUS. *Leidy.*

Proc. Acad. Nat. Sci., Phila., 1869, p. 66.

Tertiary, at Church Buttes, near Fort Bridger, Wyoming Territory, discovered by Dr. F. V. Hayden.

TRIONYX FOVEATUS, *Leidy.*

Pr. A. N. S., 1860, p. 148.

From the Upper Jurassic Bad Lands of the Judith River, Nebraska.

TRIONYX PENNATUS, *Cope.*

Pr. A. N. Sci., 1869, p. 12.

This species is represented by the distal half or less of a single costal bone. It indicates a large species of size similar to the Trionyx-priscus, Leidy, and of a peculiar and handsome style of sculpture. The bone thickens distally, and the margin is heavy and truncate, and rises abruptly above the free extremity of the rib proper. The general surface is plane; the structure consists of strong sulci, which are as wide as the intervening ribs, which diverge slightly outwards on each side of a narrow plane line, which extends on each side along the inter-costal suture. Proximally, these grooves are continuous across the costal bone, forming a very open chevron, pointing outwards; but they shorten, and are separated by a triangular area of sub-round pits, which are not regular nor corresponding with the sulci; the latter shorten to the margin of the bone. The diameter of the pit is often smaller than that of the sulci.

	Lines.
Width costal bone,	25.
Thickness proximally,	3.
" distally,	4.5
" at base of free rib,	6.
Sulci in an inch, five.	

Locality—The upper bed of Green Sand in Monmouth Co., N. J. In the collection of O. B. Kinne, Director of the marl pits at Squankum.

TRIONYX BUIEI, *Cope*, *Sp. Nov.*

This species is represented by numerous costal bones in a more or less fragmentary condition. They resemble somewhat those of the T. pennatus. There are narrow transverse ridges extending in slightly curved lines from the margins to a distance inward on the costal bones. Near the middle of the length of the bone they are interrupted by irregularities and cross-ridges, producing a honey-comb arrangement, while more distally the ridges and included grooves are more continuous. Five intervals are included in six lines. Thickness of the costal bone at lateral suture, 2.2 lines.

From the Miocene, near Mt. Olive, Duplin County, N. C. Obtained by the Geological Survey of North Carolina by Prof. W. C. Kerr, Director. Dedicated to Dr. D. H. Buie, of Wilmington, N. C., a geologist and naturalist.

TRIONYX PRISCUS, *Leidy.*

Proc. Acad. Nat. Sci., 1852, p. 329. Cretaceous Reptiles, Tab.

From the Cretaceous green-sand of New Jersey.

TRIONYX LIMA, *Cope.*

Proc. Acad. Nat. Sci., Phila., 1869, p. 12.

This species is known by a costal bone, of which the proximal part has been broken away. It is the largest of our Trionyches.

The distal end of the bone is oblique and slightly concave; it is remarkably thick. The superficial sculpture is its strongest mark. This consists of numerous narrow, much elevated transverse ridges, which are finest and most closely arranged distally. They are irregular in their course, presenting occasional short interruptions, and rarely inosculate. The irregularities are most abundant proximally. The distance between the ridges is greater than the width of the same. There are five in a half inch distally, and 4.5 proximally. Probably on the proximal extremity of the costal bones the ridges are much more irregular, as they are generally less longitudinal there than distally in all our species.

Thickness at middle, distally, 9 lines; thickness at fractured edge, proximally, 6 lines.

From the Miocene marl of Cumberland Co., N. J. Found by John Hummel.

CHELONIIDAE.

No species referable with certainty to the present family, have been found in North American beds older than the Tertiaries.

CHELONE GRANDAEVA, *Leidy.*

Proc. Acad. Nat. Sci., Phila., 1861, p. 303.

This large species was originally characterized from a number of vertebral bones. Since then more abundant material has enabled me to ascertain its characters more precisely.

The ossification of the disc is perhaps more extensive than in C. mydas, if the small size of the extremities of the ribs be indication. They are very flat in both directions. The surface is smooth, or with only the vascular grooves found in the species of the family generally. A nuchal or marginal vertebral is partially preserved, having lost the posterior portion. The margin is heavy, thinner than as usual medially, and with a little irregularity where the dermal scutum crosses. The suture with the first marginal is nearly straight, except that the latter sends a flat process a considerable distance over the posterior face of the former.

The right scapula and part of the procoracoid are preserved. These have the extensive union characteristic of Chelone, and the short coracoid suture. The scapula is flattened so as to be antero-posterior above, transverse below. The procoracoid is strongly compressed to a vertical section. The head and great trochanter of the femur are preserved. These also present the characters of Chelone. The little trochanter is on the shaft some distance below the head. All but its base is lost. The great trochanter is higher than the head, and is a plane at right angles to the plane of the latter. Its extremity is conic, and its connecting portion contracted and descending below the line of the head.

	Lines.
Width of costal bone,	39.5
Thickness " at suture,	6.
" of nuchal bone at marginal suture,	9.
Length neck scapulo-procoracoid,	42.
Width " "	18.
Length coracoid suture,	18.
Depth procoracoid at middle,	16.
Length scapula to infer. side,	38.
Width " extremity,	20.
Transverse diameter shaft femur,	22.8
Diameter shaft and great trochanter,	45.3

The accompanying cuts show the forms of the head of the femur and of the scapula.

Another specimen in the museum of the Academy, from the same locality, exhibits the characters of four marginal bones and a fragment of one of the hyosternals. In general characters the middle and posterior of the former are

Fig. 40.

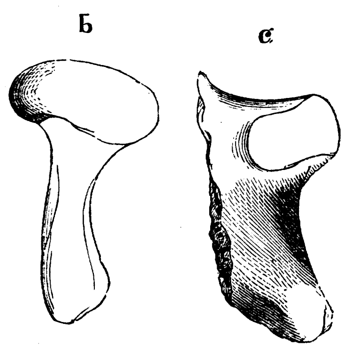
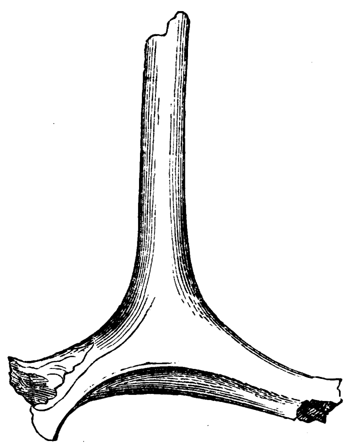


Fig. 41.



like those of Propleura; the anterior presents the characteristic slenderness seen in Chelone. One end of the latter is broken; the remainder measures four inches in length, 22.5 lines in width, and only 10.5 lines in depth medially, being flat and thin. The outer margin is flat and entire. The inner presents two shallow pits at its posterior part, close together, the hinder partly on the suture with the adjoining marginal, and directed a little forwards; the anterior directed backwards. As this is probably the anterior rib-bearing, or third marginal, it looks probable that

the free rib of the corresponding costal bone is directed obliquely backwards to the posterior part of the marginal and somewhat in the line of the outer extremity of the costal, instead of parallel to its lateral sutures, as in the others, which brings the rib to the middle of the marginal bone. That this is the case, is proven by the extremity of the corresponding costal bone. The direction or the free portion of the rib, instead of being parallel to the inter-costal suture, makes with it an angle of about 35°. This is a marked character, and not present, so far as I am aware, in any of the recent species.

A more median marginal is thick, and quite trigonal in section, and narrower than in the Propleuras: width below, 28.5 lines; depth of inner (concave) face, 21.5 lines; the measurements are approximate, as the margins are worn. The margin has a strong emargination near the middle. Two more posterior marginals exhibit a pronounced, but more open notch. Length of one of these 3 inches, 10.5 lines (median); width at notch, 30 lines; greatest width, 34 lines; depth, 12 lines. Inferior face transversely convex, margin not revolute. In all, the dermal intermarginal suture is distinct, crossing a little behind the middle.

The portion of hyosternal is that of a Chelone, and not Chelydriform.

Another species probably occurs in the same bed, but being indicated by the marginal of the young, it is not ready for description.

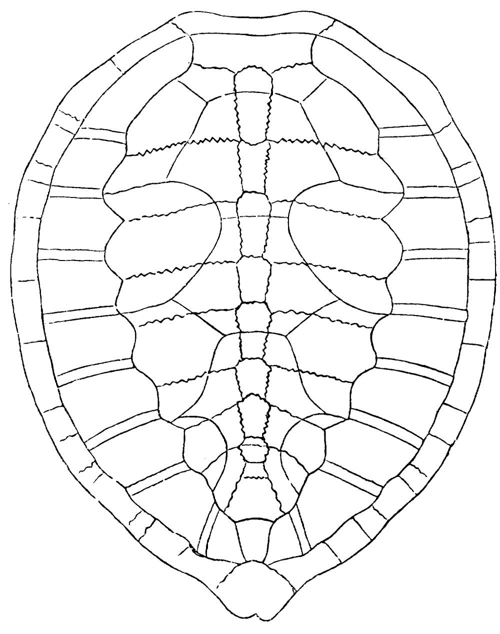
CHELONE PARVITECTA, *Cope.*

Chelone Cope, Sp. Proceed. Acad. Nat. Sci., Phila., 1867, 143.

This species is indicated by a costal bone from Squankum, N. J., and by a part of another from Charles County, Maryland. It is characterized by its lightness, and by the breadth of the dorsal dermal scutum, as compared with the length of the bone, which indicates an abbreviation of the latter, and relatively small size of the carapace. The character of the broad scute and short costa is one of immaturity; but the margins of the former are curved, indicating length, and an adult outline; and the surface of the bone has a peculiar sculpture, not found in the C. grandaeva Leidy, the other species from the same beds. The latter is larger, and with smooth costal bones of regular thickness in specimens of the same size as the present.

The costal of C. parvitecta is light. Its surface is marked by longitudinal impressed grooves, which are more or less confluent; the surface is thus more or less tubercular. On one of the sutures the grooves run transversely to the bone for about half its length. Within the suture of the vertebral scutum the surface is strongly punctate; external angle of vertebral scutum less than right; sutures well marked.

Fig. 42.



CHELONE MIDAS LINN.

	In.	Lin.
Length costal bone without rib,	5	
" " to angle vertebral suture,	1	10.5
Median width costal bone,	1	9.
Thickness " at rib,		4.2
" " at margin,		2.5

Position—Probably the Miocene. The rib above described is in the collection of O.

B. Kinne, Director of the Squankum Company's marl excavations, Squankum, Monmouth County, N. J.

PLEURODIRA.

This division of the order, now found only in the southern hemisphere, had, in Mesozoic and Cainozoic time, as is known to geologists, a much more extended distribution. It has presented to various naturalists the appearance of a repetition under another type of structure, of the groups of Cryptodira. Agassiz, in his contributions to the Natural History of the United States, Vol. I., states that he believes it to form a series of families parallel with those of the other suborder; but he does not attempt to define them. He gives as types of these families Chelys, Sternothaerus, Pelomedusa, Hydraspis, Chelodina, and Podocnemis. After some examination of their structure, assisted by an essay on their cranial characters by Dr. Gray,* I believe that four such families exist, the types of which are Pelomedusa, Sternothaerus, Hydraspis, and Podocnemis. I have already indicated the fact that Pelomedusa has the foot of the Testudinidae. I also find that it has the rudimental *intersternal* bone, as figured by Wagler in Podocnemis, and that Sternothaerus has this bone complete on each side, entirely separating the hyo- and hyposternals, as in the extinct, and till now uncharacterized family of the Pleurosternidae. The Hydraspididae have neither this bone nor a zygomatic arch, but a peculiar parieto-mastoid arch, as in the Chamaeleons. These characters are shared by Chelys, Chelodina and others. Podocnemis adds to the zygomatic arch, the lateral-intersternal bone, an Emydoid foot, and no parieto-mastoid arch.

The extinct species of the Pleurodira, as yet found in Europe, belong to the Sternothaeridae and Podocnemididae. This I have readily determined from the good descriptions and figures given by Professor Owen in the Paleontographical Society's volumes.

STERNOTHAERIDAE.

To this family belongs the Platemys bullockii Owen, from the lower Eocene. It represents a genus which I call DIGERRHUM, which differs from Sternothaerus in having the anterior lobe of the sternum immobile, and two ranges of marginal plates, as in Pleurosternum and Chelone.

PODOCNEMIDIDAE.

To this family belong *Emys laevis* and *Platemys bowerbankii* of Owen, who compares the latter species to Podocnemis. So far as I can see they both appear to belong to the genus Podocnemis, and may be called Podocnemis laevis, and P. bowerbankii.

To this family may perhaps also belong the genus.

* Proc. Zool. Soc., London, 1864.

BOTHREMYS, *Leidy.*

Cretaceous Reptiles, p. 110–113, which differs from Podocnemis as Chelys does from other Hydraspidæ, *i. e.*, in having an osseous vomer. This is, however, only a generic character. Its characters are more fully pointed out under Euclastes, while we refer to Leidy's excellent description and figure for other details.

BOTHREMYS COOKII, *Leidy.*

Is only known from a cranium from the Cretaceous Green Sand of Gloucester Co., N. J. It is in unusually good preservation, but has not yet been associated with its carapace and other elements. It will probably be found to belong to either the following genus, or Prochonias, in which case the latter becomes a synonyme.

Probably to the Podocnemididæ also is to be referred the new genus,

TAPHROSPHYS, *Cope.*

American Naturalist, 1869, 90.

Which presents the characters of Podocnemis in several respects. It has like it an inter-marginal sternal bone on each side, which does not extend to the median line, as in Sternothaerus. The other characters are as follows:

Ischium, with a small attachment on the posterior margin of the xiphisternal bone; pubis, with a linear attachment on the same, each well separated from the other. Ilium received into a deep, elongate pit on the last two costal elements of the carapace. Antero-external angle of the hyosternal bone received into a strong pit near the margin of the first costal. Postero-superior or inguinal prolongation of the hyposternal received into a deep linear groove of the corresponding costal bone. Intergular dermal plate, intermarginal; nuchal plate, none.

The marginal bones at the sterno-costal bridge have somewhat expanded margins, though their inferior aspect is not in the plane of the sternum. This point, and the absence of the nuchal scute, are points of resemblance to Podocnemis. The latter genus differs in having a marginal intergular and round pubic suture scar. The anterior or nuchal marginal bone is much larger than the first or second lateral, and is opbyriform, being much wider behind than at the margin. The vertebral bones are continued to between the costal bones which support the ilia in one example of T. molops only. There are strong vertical inguinal and axillary supports of the carapace, which are transverse continuations of the hyo- and hyposternal bones in those positions, and their articulations with the carapace are by a strong gomphosis.

In this genus, as well as in Podocnemis, the attachment of the marginal bones to the

costals is without gomphosis, and by light squamosal suture, except in front and at the bridge, where the suture is closer and the bones thicker.

In three species the iliac pit has been seen in numerous specimens from both sides of the carapace. In all cases it is very elongate, opening posteriorly on the plane of the costal bone. It extends to near the margins of the last and penultimate costals, commencing near the proximal or vertebral end. The pit which receives the axillary buttress is well defined, near the extremity of the first costal bone; the end opposite to it is crossed by a suture of the first vertebral scutum; a ridge also extends from the pit to the capitulum: just anterior to the latter a strong crest probably represents the connate first rib, which is free in some Emydidæ.

The posterior lobe of the plastron is deeply emarginate.

The materials on which the generic and specific characters of the tortoises included undei this head have been based are abundant in the middle bed of Cretaceous Green Sand in New Jersey, but are usually obtained in such a fragmentary condition as to require much labor for their interpretation. The case has been especially difficult in the present genus, owing to the difference in the sculpture of different parts of the same carapace. These varieties are the longitudinal parallel grooved surface, the coarser and more finely reticularly grooved, and the plane; the last either erose or smooth. The reticulate groove is sometimes so deep, and the areolæ so raised as to be truly tubercular.

These differences indicate both parts of the same species and different species. The longitudinal grooving is characteristic of the costal bones of Taphrosphys strenuus, and the costal and some thoracic bones of T. molops. The reticulate sculpture is close on the marginal bones of T. molops and T. sulcatus, closest on a portion of the bridge of the former. It is coarse and open on the abdominal bones of T. molops and T. sulcatus, but often passes into an eroded surface, which gives no distinct pattern, but is generally roughened. In P. nodosus the reticulate sculpture is so close and strong, as to leave tubercle-like interspaces; while P. enodis is entirely smooth

Six species may be clearly distinguished. They differ considerably in the forms of the mesosternal bones, and their relations to the intergular scutum, which covers them in part. The forms of the pubic and inguinal sutural articulations are also quite characteristic, as well as the relative thickness of the shells. In size the species vary from that of an average snapping turtle (T. leslianus) to that of the largest sea turtles (T. strenuus.)

Synopsis of Species.

a An azygus bone in front of the caudal marginal. *Taphrosphys.*

Mesosternum transverse, broader than long; intergular scute, not reaching the posterior border; first vertebral scute shorter; shell heavy; pubic scar wide, much elevated; xiphisternum thin edged; large size. T. MOLOPS.

aa No azygus bone in front of caudal marginal. *Prochonias.*

Mesosternum transverse, intergular scute extending to its posterior suture; first vertebral scute elongate backwards; shell thin; pubic scar wide, not elevated; inguinal costal pit plane, xiphisternum thin edged; size medium. T. LONGINUCHUS.

Mesosternum longitudinal, narrowed; first vertebral scute shortened; costal bones reticulate sculptured; pubic scar long, narrowed, not elevated; inguinal costal pit plane; xiphisternum thin edged; size large. T. SULCATUS.

aaa Posterior vertebrals not known.

Mesosternal bone as broad as long; the intergular scute not reaching its posterior margin; first vertebral scute shortened; inguinal costal pit plane; shell thin; size smaller; pubic scar wedge-shaped. T. LESLIANUS.

Mesosternal? costal bones reticulate or parallel grooved; inguinal costal pit elevated inwardly, descending to usual plane distally, its fundus keeled; xiphisternum with thick obtuse margin behind; shell thick, vesicular inferiorly; very large. P. STRENUUS.

Carapace thin, surface sculptured with tubercular, ridge-like or vermiform prominences in strong relief; angle of bridge obtuse; size large. P. NODOSUS.

Either Prochonias or Taphrosphys may hereafter be found to be identical with Bothremys, Leidy.

TAPHROSPHYS MOLOPS, *Cope.*

Large, stout; costal bones, 3.6 inches in thickness at their proximal portions; the posterior narrower than the anterior, and thinning out exceedingly at their extremities. Hyosternal 3.6 lines thick behind, costal plates with longitudinal grooves, marginals and parts of plastron reticulate, other parts of plastron open reticulate, or with inosculating striæ. Proximal end of anterior rib-plates very coarsely reticulate. Vertebral scutes large, as broad or broader than long, with straight margins. Some of the costal capitula small, others large, those of the first pair with a high projecting keel alongside of them, which have sutural extremity next the vertebra.

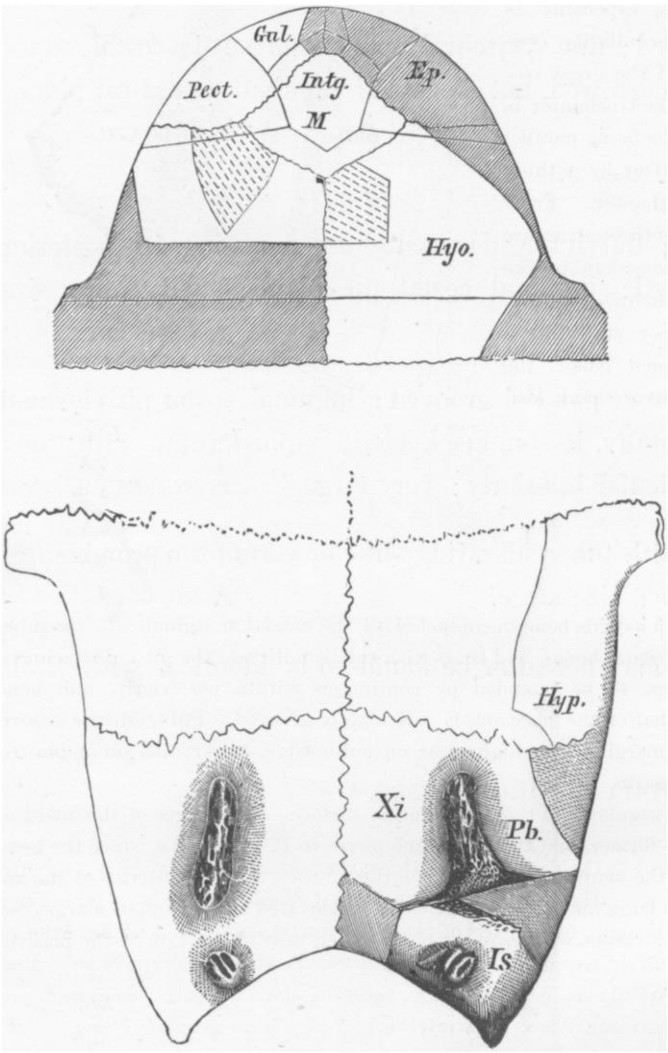
This species is indicated by many specimens. Among these may be mentioned a large part of the carapace and plastron of an individual from near Barnesboro, fewer parts of another from Gloucester County, New Jersey, and part of the carapace of two others from Birmingham, Burlington County. Also, one costal and two sternal bones, in the possession of the State Survey of New Jersey, at New Brunswick, from the middle green sand bed of Tinton Falls, Monmouth Co., N. J., with fragmentary specimens from various other places.

These show the species to have been more massive than the P. sulcatus; all the pieces, but more especially the costal bones, are thicker and heavier.

The first costal bones are remarkable for a deep curved elongate pit with raised edges, for the purpose of receiving the upper extremity of the hyosternal axillary buttress. It is deepest posteriorly, and is curved forwards and inwards. The distal margin presents two outlines, both thinned out and in contact with a marginal by a weak squamous suture, without any gomphosis. Indeed, the recurrent part of the margin, which formed a notch in the disc, was not

probably in contact with marginal bone till maturity. These costal bones are gently curved, and with longitudinal shallow grooves of sculpture.

Fig. 43.



The individual of which the greatest number of fragments is preserved, is from near Barnesboro, shows that the reticulate sculpture of the marginal bones at the bridge is distinct above, obsolete below. There are three and parts of two others in the bridge in Platemys and Emydoids; three of those of P. sulcatus Leidy are known; two of those of the present species are preserved. Both have been wholly attached to the plastron; one has an acute, but not thin or recurved outer margin; the other is strongly obtuse. All three of those of T. sulcatus are, according to Leidy, thin and recurved.

	In.	*Lin.*
Length of obtuse marginal,	2	6
Width of inferior face	1	9

The edges of the anterior marginals are thin and acute, not revolute nor notched.

	In.	*Lin.*
Width margin of median vertebro-marginal bone,	1	8.
Width marginal scutum, next it,	2	6.
Length " "	2	4.5

The free lateral margin of the hyposternal is obtuse, not thickened or grooved, thinning a little near the suture with the xiphisternal.

The sternum in general is not thick in this specimen; in the thickest portion of the hypo-hyosternal suture 5 lines; in a fragment of another no doubt larger specimen, 7.5 lines. The mesosternum, with the dermal sutures is fortunately preserved; the former is transverse diamond shape. The character of the plastron, except the hyosternal region, may be learned from the accompanying cuts of restorations. A cut of the axillary pit and its position is also given.

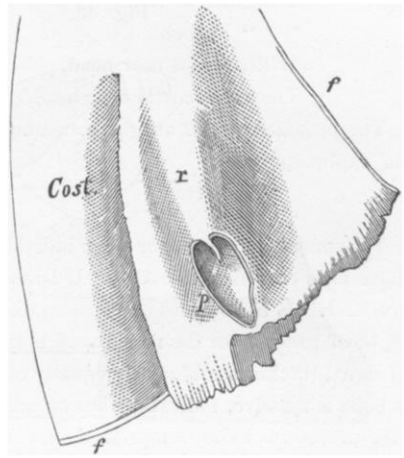
In a fine specimen from Hornerstown, for which I am indebted to Jno. G. Meirs, the lateral intersternal bones are easily seen. They present a rounded interior outline, and apply to an equal extent of the hyo- and hyposternal bones. They extend but one third the distance to the median longitudinal suture, and are much as in the Podócnemis of the Amazon. Posterior lobe of plastron 10.5 in. wide, between inguinal notches.

One of the costal bones from Tinton Falls exhibits the pit for the inguinal buttress. It differs from that of the pubis of the other specimens, and of P. princeps and P. enodis in not being situated on an elevated ridge or pedestal,

but is a narrow pit with the margins much raised, and with a delicate carina along its middle; sides little rugose. Length of fossa 1.5 inches; it is parallel to the costal suture, at a distance of one inch.

The specimen from Birmingham accompained that of the Lytoloma angusta, and a femur. As the proximal region of the latter has no resemblance to that of any Cheloniid, I suspect it belongs to the genus Taphrosphys, especially as its size relates to that of this species. Its peculiarity consists in the head being very much compressed, and the great trochanter smaller and in the same plane. The lesser trochanter is opposite the middle of the side of the head, its plane being parallel with that of the head, and connected with the latter by a thick cross-bridge; it is independent of the great trochanter. From the outside the articular face of the head extends through an arc of 190°. The distal extremity of the femur is considerably like that of the Propleura sopita. The shank is narrow, and rapidly expands to the condyles, and on the inner side into a prominent rugose ridge. Condyle quite prominent below, the inner most so; shank next to them striate. Middle of shank lost.

Fig. 44.



	In.	*Lin.*
Length of axillary pit,	1	7.5
Greatest width,		8.
Width on costal bone,	2	0.5
Diameter head femur,	1	2.5
" condyles do.,	1	4.

Another specimen from Barnesboro exhibits an azygus bone in contact with the caudal marginal. It resembles the coössified proximal portions of the last pair of costal bones, and bears with the penultimate the pit for attachment of the crest of the ilium. It appears, however, to be bounded by continuous suture posteriorly, and hence is perhaps a vertebral bone. Its surface, like that of the plastron, is reticulately grooved. Pubic suture grooved medially directed inwards from lateral sternal margin, with high crest on outer edge, larger; margin of plastron dilated, thin; marginal bones thick, with heavy margin.

The free margins of the xiphisternal thin out regularly to the flat inferior surface. The edges of the marginal bones are, on the contrary, much thicker than the former, and than the same pieces in P. sulcatus, since the heavy portion is much nearer the margin, Sutures of the scutes are apparent on these bones, and the anterior of the anal scutum on the xiphisternal. The ischiadic scar is large and on an elevation; it is elevated on the outer margin, and deeply grooved in the middle line. A sub-round elevation, with cross ridges, situated near the margin of the plastron, is the attachment of the pubis.

	In.	*Lin.*
Length of ischiadic suture,	2	1.5
Width " "		7.3
Distance from nearest margin behind,	1	6.5

The posterior vertebral has a peculiar form, and if correctly identified would indicate a short caudal and shortened ultimate costal bone. It is thicker than any of the costal bones of other species, and has at its anterior part below, a short longitudinal ridge. Its sculpture is like that of the sternum, composed of inosculating grooves, forming a coarse figure. Its anterior outline is transverse; antero-lateral, oblique; latero-posterior, straight longitudinal not continuous with the former, but with a short margin at an obtuse angle, which proceeds from the antero-lateral at a projecting right angle. Posterior suture concave, to meet the posterior or caudal marginal. Latero-posterior margin bevelled below. Penultimate costal narrowing proximally, and supporting the longitudinal elevation which bounds the iliac pit anteriorly.

	In.	Lin.
Antero-posterior extent of last vertebral,	2	4.
Width to middle line,	1	7.5
Thickness in front,		8.
" behind,		5.5
Width costal near head,	1	9.
Thickness costal near head,		5.

The presence of this azygus bone may be abnormal, in which case the group *Prochonias* will not be distinguished from Taphrosphys.

VAR. ENODIS, *Cope*.

This may be a smooth or worn individual of T. molops. The remains are in good condition, and do not appear to have been eroded or corroded. It is indicated by a large portion of the plastron of a single individual from Barnesboro, N. J. It is a species of considerable size and solidity, and is distinguished by the entire absence of any sculpture, or of grooves for the margins of horny scuta. The external margin of the whole length of the hyposternal bone is of equal thickness and nearly equally obtuse, a circumstance uncommon among tortoises. The vertical portion of this bone is massive, indicating strong union with the carapace. The margin of the hyosternal, descending from the bridge-process, is more compressed and acute, as are also other portions of the margin of the anterior lobe of the sternum.

The ischiadic scar is not far behind the hyosternal suture, and is quite elevated on a broad base. It is wider behind than before.

Measurements.	In.	Lin.
Length of hyosternal from middle of vertical process,	4	3.
Thickness of margin of do.,		5.
Length of pubic scar,	1	10.2
Distance behind hyosternal suture,	1	2.5
Thickness of xiphisternal near do. suture,		5.

This may be an old T. molops worn smooth.

Position:—The upper green-sand bed of the upper cretaceous of New Jersey.

TAPHROSPHYS LONGINUCHUS, *Cope*.

Spec. nov.

Established on a nearly complete but much fractured individual, from the excavations of David Haines, N. Jersey.

This is one of the smaller species, and is of light construction, though rather stouter than the T. sulcatus. In many points it resembles the latter species, but differs in many others.

A marked peculiarity is seen in the greater posterior prolongation of the first vertebral dermal scutum. Its posterior suture enters the first costal bone considerably nearer the costal than the nuchal suture; it is considerably nearer the nuchal than the costal in T. molops, T. sulcatus, and T. leslianus. The costo-first-vertebral dermal sutures are thus less divergent than in T. leslianus, at least. The suture with the first vertebral bone is quite concave. The axillary pit is strongly marked, but not so much so as in T. molops.

	M. M.
Width first costal bone (proximal),	0.0645
Thickness (posterior),	.0085
Width from costal suture to transverse dermal,	.026
" axillary pit,	.0125

Three vertebral bones indicate that the most elongate are not so slender as those of the genus Trionyx. The lateral outlines are straight and make an open angle with each other, the short anterior and posterior are gently convex backwards. The last vertebral bone is small and subround. Three rudimental vertebrals were attached beneath the

penultimate and ultimate costals, covering their sutural union, as indicated by sutural areas remaining. The penultimates are separated anteriorly by the round bone above mentioned; their posterior united halves supported the first supernumerary vertebral. The remaining two were beneath the last pair of costals. Pygal bone sub-triangular with two obtuse ridges medio-anteriorly, and a slight projection laterally in front. This whole region is precisely like that in T. sulcatus.

The iliac pit is much like that in T. sulcatus, but the anterior bounding ridge is wanting for most of the length; the distal extremity of the same, also, is not distinctly outlined. The inner margin is more so, by an elevated ridge or ridges. Proximally its margin is partly formed by the rudimental costal, of a subcubic form attached by a suture in a pit, as in T. sulcatus.

	M. M.
Length average vertebral,	0.035
Width, greatest,	.025
" anterior,	.0075
" last vertebral,	.019
Length " "	.017
" pygal,	.061
" united extremities two last costals,	.036
" penultimate costal,	.104

The vertebral regarded as of average form exhibits but a short lamina or neural spine connecting the arch and superior plate. The neural arch is not coössified with the centrum, and the capitular articular face is well developed.

The inguinal articular pit is strongly marked and rather wide; distally its fundus is continuous with the plane of the costal bearing it.

	M. M.
Length inguinal pit,	.032
Width " "	.006
" costal bone bearing it,	.0475
" average costal bone,	0.33

A marked character of the species is seen in the mesosternal bone, one-half of which is preserved. From the acute angle formed by the extremity, it is evidently even more transverse than that of T. molops. The sutures are very coarse, as in other species, the anterior directed forwards, the posterior outwards. The intergular scute is larger than in the other species, as its right margin extends nearly to the outer and posterior sutures of the bone. All the sutures of the plastron are coarse.

The axillary margin of the hyosternal is not thinned; that of the xiphisternal is thinned, and they enclose a wide median emargination behind. Their extremities are not so acute as in one example of T. molops. The iliac scar is very prominent and rugose. The pubic scar is longer and much wider in proportion to the general size, than in T. sulcatus, and is wider behind than before. It is not elevated as in T. molops. Its sutural ridges are very numerous and acute.

	M. M.
Length from median suture to xiphisternal posterior angle,	.059
" xiphisternal scar,	.037
Width " " (greatest),	.0085

The marginals are like those of T. molops, on a smaller scale. The posteriors are light, the anterior heavier, those of the bridge present a small angle, but not thin nor revolute. The reticulation is with their length. Length and width of a posterior marginal about equal, viz: m. 0.0465.

The scapula is continued into a procoracoid with axis at right angles to it, and length of union not great, but about as in Emydioid Pleurodira.

	M.
Diameter glenoid cavity,	.014
Length of scapulo-procoracoid neck,	.021

The humeri are short, with stout head and condyles, slender shaft, and considerable curvature. Head presented inwards and upwards; condyles downwards, the outer angle most prominent. A slight tuberosity on inferior aspect near inner angle. Outer outline of shaft quite concave. Deltoid ridge a prominent crest, its posterior margin falling considerably short of the head; the outer margin continuous, convex. Postero-inferior crest broken; the planes of the two make a little more than a right angle with each other.

	M.
Total length humerus, (straight)	.097
Diameter condyles,	.025
" deltoid crest to middle shaft,	.02
" shaft at middle (transverse),	.009

Nothing but a fragment of the great trochanter with head, is left of the femur. The former is continuous with the latter, straight; with flat outer side, and narrow. Form quite as in Propleura.

This individual appears to be mature. Its remains are accompanied by a few fragments of a large individual, of this species or T. sulcatus.

Position. The upper green sand bed of the Upper Cretaceous of New Jersey. Discovered by John Haines.

TAPHROSPHYS SULCATUS, *Leidy.*

Platemys sulcatus, Leidy. Proceed. Acad. Nat. Sciences, Phila., 1856, 303. Cretaceous Reptiles, 109. Tab. XIX, fig. 4.

Pubis attached to a narrow, little elevated longitudinal sutural surface. Margins of sternum thin, flat; surface deeply recticulate grooved; bones, especially the marginal, thin, light, costals thinned at margins; mesosternum longer than wide.

This species is so fragile as to be rarely preserved in more than a few pieces. The largest part of a single individual that has come under my notice, consists of the more or less complete posterior three costal bones of the carapace, with last vertebral marginal, some anterior costals, xiphisternum, etc. Another similar series of fragments of another individual was procured at the same time and place, *i. e.*, near Barnesboro, N. J.

These specimens show that the last pair of costals is not separated by a vertebral bone, and the penultimate pair is only separated at their anterior part. This last vertebral is of reduced and rounded proportions; the one preceding it is of the normal form, *i. e.*, with elongate postero-lateral border. The costal capitula are developed on all the bones. Sutural surfaces are present on the inferior face of the proximal and contiguous pairs of costal bones, for the attachment of rudimental and inferiorly placed vertebral pieces. One elongate extends from the last true vertebral over the anterior margin of the last pair of costals. The latter have two scars; the anterior rectangular, the posterior ovate. The pygal bone is elongate ovate anteriorly; inferiorly it presents a flattened longitudinal ridge, and an elevation on the anterior part of the lateral margin.

The last costal has a very irregular inferior surface. Its proximal part is thickened, and then rises outwardly into the ridge, that margins the iliac pit. This ridge is most elevated on the capitulum, and develops an acute process outwards from it. The posterior part of the pit is occupied by an ovoid bone, truncate outwardly where it articulates with the ilium, which appears to be a rudimental costal element belonging to the second rudimental vertebral piece. It presents a rudimental capitulum towards the latter.

Behind this piece a narrow transverse groove extends outwardly, and is bounded by a longer groove anteriorly and a short one posteriorly. Near the distal extremity of the bone is a thickening, which terminates abruptly round an ovate posterior margin. Its anterior margin is on the posterior edge of the preceding costal bone. The distal margin sends a short process downwards.

The penultimate is characterized by the high crest a little in front of its posterior margin, proximally, which encloses in front the iliac pit. The crest continues distally, and turning abruptly encloses the extremity of the pit.

The external margin of the last costal is strongly angulate; the penultimate less so. As in all of our Pleurodira, the marginal sutures are half squamosal, and with striiform ridges.

The external sculpture is coarsely reticulate, tending to enclose areas longitudinal with the costals towards their middle and distal portions. That of the marginal bones is closer. The dermal scuta are separated by sutures indistinctly marked on the carapace in all the species of our Pleurodira. In this species the vertebrals are very broad.

and with external angles less than a right angle. It marks the proximal third of the costal bone. The posterior is truncate behind; the pygal is considerably longer than broad.

Proximal halves of the two first costals, with the costal crest for the first pair of ribs, are preserved. The suture for the first vertebral bone is little concave. The inter-vertebral dermal suture crosses it, just anterior to the point opposite to the completed capitulum of the bone.

The xiphisternal, besides being much thinner relatively than that of Taphrosphys molops, is of different form; while its hyposternal suture forms nearly a right angle with the common suture; in the latter species, an acute angle. The pubic scar in P. sulcatus is of nearly the same length, but much narrower and less elevated. This I have observed in five specimens. The posterior lobe of the sternum is deeply emarginate. The pubic scars in both converge slightly anteriorly.

The second specimen, above mentioned, furnishes portions of marginal bones and sternal bridge. The latter presented an obtuse angle between the lateral and inferior planes. It also possesses the mesosternal, somewhat broken. Its external angle is considerably more than right, and indicates a thin bone considerably longer than wide, and more like that of P. leslianus than any other species of the genus.

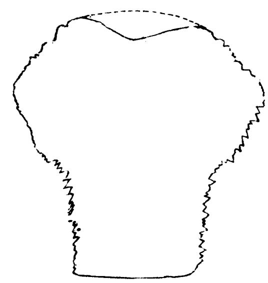
Measurements of Spec. No. 1.	*In.*	*Lin.*
Length of ante-penult costal bone,	7	9.
Width " proximally,		20.
" " distally,	2	7.
" penultimate proximally,		15.5
" posterior vertebral,		14.5
" posterior costal proximally,		13.
" " distally,	2	4.
Length of "	4	9.
" iliac scar,	3	
" rudimental costal,		7.
" caudal marginal,	2	10.
" suture between posterior pair marginal scutal,		19.
Width of caudal marginal,	2	7.5

This is a species of considerable size. The fragments originally described by Leidy are three united marginals from the position of the sternal bridge. They show that these elements have a thin junction with both plastron and carapace, and are not separate from the latter, as one might be led to suppose.

The marginals near the bridge have a flat and broad inferior surface, and are produced into a narrow slightly recurved margin, while the free marginals have the external face plane—not recurved—and the internal thickened a line within the margin.

What is probably a nuchal margin (from Barnesboro, Professor Cook's Collection) is not thickened within, and has, as in other genera, a much greater transverse extent posteriorly than at the margin. Its form is as follows: Length, 2 in., 8 lin.; width, 2 in., 6.5 lin. A peculiarity in the dermal markings is that there is no nuchal scutum, but a suture as in the caudal marginal bone.

Fig. 45.



Two marginal bones, having the sculpture characteristic of this species, appear to be referable to it after comparison with specimens in the Museum of the Academy. One, a median posterior, is considerably shorter than the other, probably a posterior or lateral, a peculiarity not seen among living species. The latter has a thin edge, is thickened along the line of the lower two-fifths the diameter, and then thins out to the upper suture, which is only 1.5 lines wide.

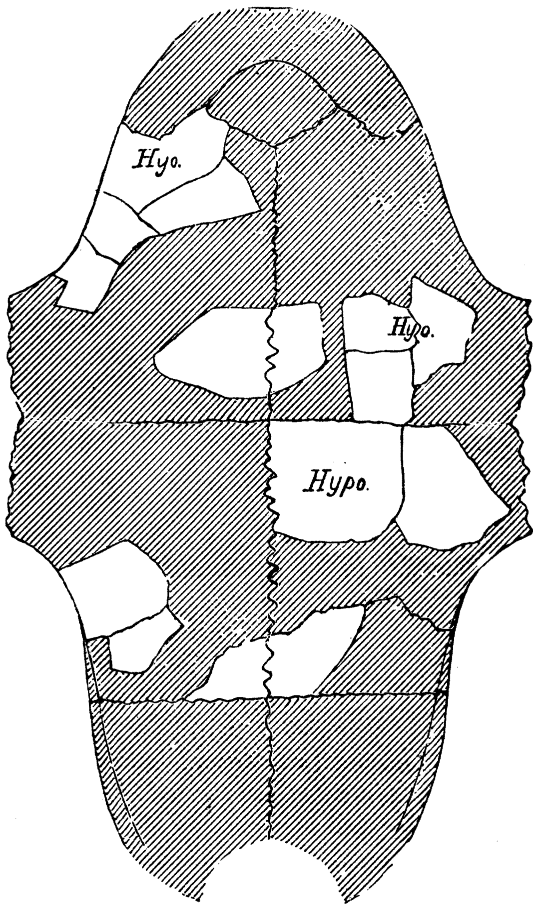
	In.	*Lin.*		*In.*	*Lin.*
Width of lateral plate,	3	0.5	Length of caudal,	2	7.
Length "	3	4.5	Width "	2	8.

These plates are crossed in the usual manner by the sutures of the marginal and costal scuta. They are all from the Birmingham pits.

The plastron of this species is relatively much thinner than in the other species of the genus.

A sternum, probably, of this species, is in my collection. It is unfortunately without the xiphisternal pieces, but conforms in all respects with what we know of P. sulcatus. Its surface has been injured by pyrites. It is characterized by its thinness and general lightness, as well as by the singular form of the hyosternal element. The remains consist of a large portion of the plastron, and two costal bones, found in the marl excavations of the West Jersey Company, near Barnesboro.

Fig. 45.



The external surface of the plastron exhibits neither sculpture nor impression of sutures of scutes. It is slightly rugose in some places. The free margin at the axillary and inguinal regions is obtuse, but becomes thin a little distance before reaching the episternal and xiphisternal sutures, respectively.

The suture between the hyo- and hyposternals is straight and fine, while that between hypo- and xiphisternals is straight and coarse. The longitudinal median suture is irregular and very coarse. That between hyo- and episternum is remarkable in its direction, thus distinguishing the species from Adocus pravus, with which this plastron might otherwise be compared. It advances posteriorly on the outer part of the hyosternal, causing its junction with the margin to be an inch behind its junction with the mesosternum; the reverse is the usual relation in tortoises.

The bones of the plastron, while more than half as wide again as those of A. beatus, are medially scarcely half so thick; the thickness increases to within a certain distance of the outer margin.

The accompanying restoration of the plastron is merely designed to illustrate the form and characters of the sutures described. The outlines of the mesosternum are erroneous; the piece is longitudinal, not tranverse; it had not been obtained at the time the cut was made.

Measurements.	*In.*	*Lin.*
Total width plastron externally, within elevations of bridges,	11	10.
Length hyosternal, on margins, from first rise at axilla to episternal suture,	3	8.
From latter to mesosternal suture,	1	10.75
Thickness hyosternal at middle sut.,		4.25
" hyposternal " "		2.8

TAPHROSPHYS LESLIANUS, *Cope.*

This is a smaller and more delicate species than the last, and differs in many particulars. It is found on a single individual, which, though not more than half the size of the T. sulcatus, is evidently adult. The portions preserved are a considerable number of the element of carapace and plastron, but none other. The union of the costal and marginal bones is complete. The first costal has the same form as in T. molops, bearing as usual, a crest representing

an anterior rib. The axilliary pit is less prominently margined by a high osseous wall, and it is elongate and curved forwards, nearly reaching the margin of the bone. The rib head is complete.

With its fellow, it embraces a first vertebral, which is about twice as long as wide and six-sided. The sides are in the order of their length: posterior (shortest), anterior, postero-lateral, antero-lateral. The anterior marginal is narrow in front. It expands so much posteriorly as to make the first lateral almost triangular. The second marginal is nearly quadrate. The edge of these marginals is thin above the nape, and thickens laterally. In the posterior it is gradually thinned out and a very little recurved. The second vertebral bone is not so long as broad: those following increase gradually in length.

The narrow extent of the hyposternal bone in front of the inguinal crest indicates as in T. molops, an intermarginal sternal. The sutures retires posteriorly from that point, suggesting the continuation of that bone towards the middle line. The cavity of the plastron is extended well laterally at the bridge. The hypo-xiphisternal suture is nearly transverse. The pubic scar is little elevated, and broadest posteriorly. Its median crest extends throughout the whole length. The posterior margin of the xiphisternal is not preserved. The mesosternum is of a rounded form, but obtusely pointed behind, and with lateral rounded projections. The posterior sutures are bevelled forwards and upwards.

The sculpture is much like that of Taphrosphys sulcatus. The marginal bones have a delicate transverse reticulation, and the costals a coarser longitudinal one. The under surfaces do not present any sculpture, perhaps, on account of corrosive action.

	M.
Length of last costal,	.08
" iliac pit,	.02
" pubic scar,	.024
" third costal bone,	.106
Width third (costal bone proximally),	.0242
" " " (distally),	.026
Thickness " " (proximally),	.007
" " " (distally),	.0025
Width first " (greatest),	.094
Length " vertebral,	.039
Width " "	.0182
" second "	.02
Length " "	.02
Length median marginal,	.068
Width " " (anterior),	.0327
" " " (posterior),	.063
" hyposternal,	.063
Thickness "	.004
Length "	.092
" mesosternal,	.0305
Width "	.0315

The dermal scuta have been thin, as in other species of this group. The sutures are all straight except that between the first and second vertebrals, which is convex backwards. The vertebrals are broader than long, and their external angle is near the middle of the length of the costal bones. The anterior vertebral is of longer form than the others, somewhat like the frustrum of a triangle, of which the base is anterior. The second marginal is wider than long; the third longer than wide. The intergular scutum is subtrigonal, the apex shortened by short facets, and extending three-fourths the distance to the posterior margin of the bone.

This species was discovered by my friend, Dr. Samuel Lockwood, who lent the single and typical specimen from his private collection for description. It is dedicated to Prof. J. P. Lesley, the Geologist, and Secretary of the American Philosophical Society.

TAPHROSPHYS STRENUUS, *Cope.*

This, the largest of our extinct Pleurodira, is represented by portions of three individuals.

The largest has been much broken up by the workmen, and many parts of the carapace and plastron are recognizable in the larger and smaller fragments.

The various elements are of great thickness, proportionately as well as absolutely, so that this is the most massive as well as largest species of the genus; in two of the specimens the episternals are considerably thickened at the anterior suture, a feature not seen in the next stoutest species, T. molops. In the first specimen, the costals have the longitudinal reticulate sculpture; the marginals close reticulate, and the sternal bones are openly reticulate. The inguinal costal articular groove is characteristic. Instead of lying in one plane as in other species, it occupies the crest of a ridge which ascends proximally to a considerable elevation, resembling in this, the pubic scar of T. molops. It is, however. nearly smooth within and has no distal boundary; the fact of its being on the middle line of a costal bone, fixes its character.

One of the elements of the plastron at one of the sutural angles, exhibits an extensive overlapping, or squamosal suture, to the extent of half the thickness of the bone, and distance of M. .028. The articular extremities of the two scapulæ are remarkable for their size. The forms of the mesosternum, and marginal bones of the bridge are unknown. The anterior marginals are thick and of coarse cellular structure. The posterior are thinned out to an edge.

	M.
Width of ordinary costal,	0.061
Thickness " "	.015
Width costal bearing inguinal groove,	.084
Thickness " " "	.013
" " at proximal part of groove,	.037
Diameter articular and scapula,	.065
" glenoid cavity (transverse),	.044
Thickness episternal at median suture,	.023
General uniform thickness of hyposternal,	.018

Of the second specimen numerous portions of carapace and plastron, with head of femur and coracoid, furnish various characters.

The costal bones are marked with shallow grooves, more closely placed than in Taphr. molops, and with less transverse inosculation. The marginals are rough from the reticulate sculpture. The abdominal surface presents a coarser and less distinct sculpture of the same kind; its dermal sutures are also distinct.

The pubic scar is lost, but the ischiadic remains. It is obliquely oval, and very near the margin of the deep posterior notch of the plastron. Anterior and exterior to it is the shallow fossa seen in the same position in T. strenuus. The anterior lobe of the sternum has convergent margins, but is broadly truncate in front, each half of the margin being slightly concave.

The point of union of the episternals is prominent, upwards and forwards. The margin of the posterior part of the episternal, and anterior part of the hyosternal, is rather thinned out, without intermarginal ridge. The suture between the two is at right angles to it, and at a little distance from it, it turns forward.

All the bones are thick except the costals, and the spongy layer is vesicular. The sutures of the costals are smooth and dense, except opposite the spongy layer.

The femur is characterized by the wide expanse of its trochanters and slenderness of its shaft. The planes of the former make an angle together of over 90°. The greater is nearly continuous with the head. The coracoid has two short sutural, and one cotyloid articular faces; its shaft is contracted and slightly curved.

	In.	*Lin.*
Width plastron in front,	6	1.5
" " at hyo- episternal suture,	12	1.5
" from mesosternal to front margir,		20.
" costal,	2	3.5

	In.	Lin.
Thickness costal,		5.
" marginal,		9.7
" episternal (average),		9.
" xiphisternal near outer margin,		7.8
Expanse trochanters,	2	3.
Long diameter shaft femur,		8.
" head of coracoid,		17.5

A large species is represented by numerous fragments from the Miocene marls of Eastern North Carolina, found for the most part by the Geological Surveyors under Prof. Kerr. This genus is Cretaceous, and is probably intrusive in Miocene beds. It occurs in fragments in connection with the cretaceous Dinosauria, Hipsibema Cope, and Hadrosaurus Leidy, in the few places where they have been found. As the species cannot be well defined, I do not name it.

A large part of the left xiphisternal, with the adjacent part of the hyposternal, the former bearing the anterior part of the pubic sutural scar, was found in the marl at James King's. The size and thickness of the parts indicate the largest species of the genus, being at least equal to the same parts in P. strenuus. As the pubic suture is not preserved in the specimen of P. strenuus, I find the distinction to be only indicated by the structure of the osseous tissue. This is very much more dense than in the species found in New Jersey, where it is very spongy and open, more so than in the other species. The inferior dense layer is thick, but not thicker than in P. strenuus. The inferior surface is somewhat worn, and does not display marked structure. The pubic scar is elevated, and bears longitudinal sutural ridges; it presents the usual obliquity inwards and forwards.

	Lines.
Thickness at hyposternal suture,	9.5
Width base pubic scar,	18.

TAPHROSPHYS NODOSUS, *Cope.*

This species is chiefly represented by a number of broken costal and marginal bones, from Hornerstown, Monmouth County, New Jersey. A costal plate with rib-head from Tinton Falls, Monmouth County, is also in the collection of the New Jersey Geological Survey, and I have found other portions near Barnesboro, Gloucester County. It is one of the rarest, as well as most strikingly marked, of our extinct Testudinata.

The costal bones are thin for their size, which exceeds that of other species of our extinct Pleurodira except the last. The prominent character is seen in the sculpture, which consists of elevated coarse ridges, forming a reticulate pattern, somewhat as in Trionyx, which are frequently broken into tubercles of various shapes, which are again confluent in some places, forming shorter or longer ribs. These may be short, curved, or angulate; there is a series of short straight ones radiating from the intercostal sutures on some of the costal bones. These projections are everywhere in strong relief. Portions of two marginal bones fix the position of the species here, and forbid any immediate affinity to the Trionychidae or Chelydrinae, though the resemblance to Peritresius ornatus cannot be overlooked. These bones are marked by impressed pits, less marked than those of the costals. They present an obtuse angle of faces, inclined at more than 90°, showing the bridge to be less angulate than in either P. sulcatus or Taphrosphys molops. On one of the costals traces of the intercostal dermal suture are visible in a continuous groove of the sculpture. Width of a costal bone 2 in., 9 lin.

I am indebted to John Meirs for this specimen, which was found eighteen feet below the surface of the chocolate marl, which lies below the upper bed of green sand.

Another individual is represented by a portion of the plastron taken from the chocolate marl near Barnesboro, at a locality different from any of the other species. There is not enough preserved to exhibit the ischiadic attachment; it is therefore uncertain to what genus it belongs. It exhibits, however, the peculiar reticulate sculpture of the P. princeps, but carried to a higher degree.

It differs in that the surface of the bone is tuberculately rugose, the grooves being deep and wide, and leaving

ridge-like and other elevations between them. On some portions of the surface they assume a longitudinal direction. A portion of the margin is rather abrupt and thick. Thickness of bone, one inch from margin less than nearer the same; greatest thickness, 6 lines.

APPENDIX TO THE TESTUDINATA.

Lembonax, Cope.

Established on the remains of a marine turtle which presents the peculiarity of a regular continuous inner margin of the hyo- and hyposternal bones, without radiating processes for intercalation with that of the opposite side, or emargination for the median fontanelle. It follows either that there is no fontanelle, or that the fontanelle is continuous to the xiphisternals, in either case differing from Chelone and Puppigerus. The hyo-xiphisternal suture is transverse, as in Emydidæ, for a portion of its length nearest the median line; or this element having transverse parallel sutural outlines may be intercalated between hyo- and hyposternals, as in Pleurosternum, though this I consider altogether improbable. The suture for the episternals oblique, and not squamosal, as in Chelone and Chelydra, but by shallow gomphosis; the anterior inner margin of the hyosternal retreating outwards a little, and leaving space apparently for mesosternum: the hyo-hyposternal suture by fine deep gomphosis; the hyo-xiphisternal by shallow coarse gomphosis.

The common neck of the scapulo-procoracoid bone is short, and more like an Emydoid than a Chelonioid.

On the whole, there is reason to suspect that this form is more nearly related to Chelydra than to Chelone.

Lembonax polemicus, Cope.

Spec. nov.

The sternum presents a longitudinal angle on each side, leaving the median plane portion of the sternal bones rather narrow, as in species of Chelone. The angle is slight, the surface rounded. The inner face of the hyosternal is strongly radiate-ridged towards the inner anterior angle, and the inner face of the margin serate; the posterior portions of the margins are slightly roughened. The inner margin of the hyposternal is regular, smooth, and thinned obtusely; it is without radiating ridges.

The external surface is smooth, without sculpture.

The sternum has been small for the size of the animal, judging by indications furnished by the scapular glenoid cavity. No portions of the carapace are preserved.

	M. M.
Antero-posterior length hyosternal,	.24
Width do. to longitudinal angle,	.136
Antero-posterior extent hyposternal,	.1525
Width do. to angle,	.155
Long diameter extremity scapulo-procoracoid,	.115
Do. neck of do.,	.098
Do. distal extremity scapula,	.059

This species was derived from the Eocene marl of New Jersey, where excavated by the Farmingdale and Squankum Marl Company, to the Director of which, A. J. Smith, I am indebted for the specimens on which the present identification is based.

PTEROSAURIA:

RHABDOPELIX, *Cope.*

This genus and species are based upon numerous bones, mostly scattered, occurring in a bed of very hard indurated siliceous clay, of a dark gray color, which intervenes between the usual redder strata in the Triassic or Jurassic sand-stone of the Atlantic slope, at Gwynnedd, Montgomery County, Pa. In the red slaty layers occur impressions of narrow leaves, worm tracks and borings, scales of Ganoid Fishes, and rain-drop and ripple-marks.

The bones, which are very abundant, are indicated by thin black mineral layers which do not effervesce in acid, and whose coloring matter, perhaps a phosphate of iron, with some carbonaceous matter, becomes blue on exposure to the weather, and is finally altogether dissolved or weathered away. In the cavities of many of the long bones may be observed a deposit of carbonate of lime. All appear to have been more or less flattened, and their walls are much attenuated. This, with the hardness of the matrix, has rendered their preservation difficult, and their identification requires much care; and though I have had them under careful observation, in the Museum of the Academy for three years, I am hardly satisfied as to their affinities. It would appear as though quite a number of individuals had mingled their remains in the accumulation, and perhaps more than one species.

The specimens were discovered by the late President of the Academy, Dr. Isaac Lea, who found considerable masses of the rock containing them, showing an accumulation which has occupied some time in formation.

There are sufficient reasons why these bones cannot be referred to a Lacertilian. They are, first, the presence of the Pterosaurian confluent ulna and radius, or tibia and fibula; second, the existence of subspatuliform, distally free pubic elements; the apparently complete pneumaticity of the long bones; the curvature and lack of condyles of most of the latter.

The centra of the vertebrae are much depressed in part of the column, thus agreeing with Pterosauria and some Lacertilia. Elongate cervical vertebrae are also characteristic of the Pterosauria, but exist likewise in the genera Compsognathus and Dolichosaurus. The centra of the vertebrae have projected considerably beyond the neural arch, and the latter has supported an elevated longitudinal neural spine, both characters of Pterosauria. Where the hypapophysis has existed it has been at the anterior extremity, as in Crocodilia and Pterodactyles, and not behind, as in Iguania.

The remains do not pertain to Batrachia, for the following reasons: The creature was of an elongate vertebral axis, and possessed none of the peculiar elements of the Anura;

it was more like a Urodele form. But the vertebrae, interpreted by the zygapophyses were procoelian, not opisthocoelian, the diapophyses were long and flattened from above, and there were elevated neural spines. Thus, while the elongate curved ribs do not differ much from those of some Labyrinthodontians, the vertebrae and other bones are of entirely different type.

RHABDOPELIX LONGISPINIS, *Cope.*

Pterodactylus longispinis, Cope, Proc. Academy Nat. Sci., Phila., 1866, p. 290.

Recognizable portions of the cranium are unfortunately wanting, except a toothed piece, which may belong to some peripheral bone, or to the mandible. This is much crushed; the teeth are slender, straight—conic, with expanded bases, from the centres of which the colored substitute for bone is wanting, as though they had been hollow pedestals. The teeth show no trace of the mode of attachment, and they may be continuous, and therefore mere processes. Intervening edge very straight.

	Lines.
Greatest depth of bone,	3.
Length, embracing four teeth,	2.5
Length of tooth,	.64

The distance between the teeth is nearly equal to the length of each tooth.

Of the vertebrae there are innumerable portions, fractured in many directions; some exposed condyloid surfaces; numerous vertical views, and thirteen complete or nearly complete profile views, from different parts of the vertebral column. The latter may be divided into those with, and those without, elevated neural arches. To the latter belong, perhaps, some elements more elongate than any other vertebrae, and with centra of larger diameter, on which no apophyses were visible; but from one extremity a centrum-like prolongation with terminal convex condyle, proximally slightly constricted. As these have been destroyed in the process of bringing out other pieces, their place and nature are problematical. They have considerable resemblance to the cervical vertebrae of Pterodactylus longirostris, as figured by Cuvier and Von Meyer. The other vertebrae, with depressed neural arch, being probably caudal, will be described later.

Of vertebrae with elevated neural arch, there are nine profiles, of which four have the neural spine a carina less elevated, and five have much elevated apophyses. In all of these the positions of ball and socket, and of the different zygapophyses, are very distinct. None of them have hypapophyses. The centrum bearing the posterior articulation or ball is considerably produced backwards and constricted slightly in front of the ball, though the diameter of the latter is small, both it and the anterior socket being evidently transverse. The posterior or despectant zygapophysis extends as far over the centrum as its condyloid extremity, in one vertebra farther, while a laterally expanding ridge marks the anterior or surspectant zygapophysis. These vertebrae are perhaps anterior dorsals, while those with elevated neural spines are median dorsals and lumbars. If this identification be correct, then vertebrae with more compressed centra, hereafter mentioned, are probably lumbars.

	Lines.
Length centrum, supposed anterior dorsal (No. 8),	4.
" neural crest,	3.
" at base neural arch,	2.
Depth, total,	3.
" centrum from anter. zygapophysis,	2.
" " anterior to condyle,	0.75

Of the supposed dorsals, one differs from the rest in its less elevated neural arch, and in its long narrow neural

spine, nearly over the posterior zygapophyses, and vertical to the plane of the centrum. The inferior outline of the centrum of this, as of all the other vertebrae, is concave.

	Lines.
Length of centrum,	3.75
" top of neural arch,	2.
" neural spine,	3.2
Depth from anterior zygapophysis,	1.75
Width of neural spine,	1.

Another fractured dorsal exhibits a broader neural spine, but its form cannot be accurately ascertained; in a third its extent is nearly that of a neural arch, and it has considerable longitudinal breadth to its crest. The centrum of this vertebra appears to be shorter than in the last, no doubt in harmony with its position as a rib-bearing dorsal.

	Lines.
Length of centrum (No. 3),	3.5
" below posterior zygapophysis,	2.
" neural arch,	3.
Height of vertebra (top of spine concealed),	6. (?+)
" posterior zygapophysis,	2.5
Depth centrum at condyle,	1.1
Length centrum (No. 15),	3 2
Height of vertebra,	4 6
" to posterior zygapophysis,	1.6

The anterior cotylus in this, as in all the other vertebrae, looks partly downwards. The superior anterior outline of the neural spine is concave, as though the straight margin were cut away to half the depth of the spine. Whether this is the natural form, or result of fracture of the matrix, is not readily ascertained; in another the full width is carried four-fifths way up to the crest.

Of what are perhaps caudal vertebrae there are profiles of six, mostly with reverses; two are very perfect. In all the inferior outline of the centrum it is markedly concave. No. 1, the most characteristic, differs from the others in possessing a long acuminate process, projecting at an angle of 35° with the axis of the centrum immediately below the posterior condyle; or, as the inferior part of the condyle is obscured by it, at the side of it. This may be looked upon as a profile of a chevron bone, or as one of a pair of lateral central processes, such as go off anteriorly in Pterosauria, Coeciliae, and Amphiumae; or, perhaps less probably, as a posterior hypophysis. That this may be the anterior exterior extremity, though furnished with the condyle, is rendered more probable by the presence of a short obtuse process immediately upon the column, and which cannot be other than the surspectant zygapophysis. It is, therefore, quite possible that this vertebra is opisthocoelian, as Seeley* has pointed out the cervicals of Dimorphodon macronyx to be. The neural arch stands only upon the two-thirds of the centrum, next the cotylus bearing extremity, and offers the free projection of the despectant zygapophysis appropriate to the opposite extremity of a vertebra, like itself. Below this extremity of the centrum is a keel-like zygapophysis of a right angled triangular form, the centrum being the hypothenuse.

	Lines.
Length of centrum,	3.5
" inferior spine,	1.25
Depth at cotylus without zygapophysis,	2.

A second and larger vertebra (No. 2) of the same type differs in the lack of zygapophysis above the condyle, and of the spine below the same. The centrum is prolonged considerably beyond the line of the neural arch; at its oppo-

* Annals Magaz. Nat. Hist., 1865.

site extremity it bears a projecting obtusely truncate hypapophysis, whose outline is separated by an entrant angle, from a similar process directed forwards and somewhat downwards. A strong lateral longitudinal ridge marks the place of the surspectant or anterior zygapophysis; bnt if this interpretation be correct, then there is not on the opposite, in that case posterior extremity of the last (No. 1), a despectant zygapophysis. The explanation of these apophyses of No. 1 must be left for the present. Below the lateral ridge, one-third the length behind the cotylus of No. 2, appears to be a foramen, resembling that described by Prof. Owen in Pterodactyles.* A second vertebra (No. 5), and a third (No. 16*a*), closely resemble No. 2.

	Lines.
Length of centrum No. 2,	5.8
" neural arch,	4.5
Total depth at hypapophysis,	4.
Depth at middle of vertebra,	2.
" of centrum near condyle,	1.5

Dorsal line slightly concave.

Two vertebrae (No. 16 and 17) exhibit characters intermediate between this type and that first described, as No. 8. They have more depressed neural arch than the latter, and less inferior concavity than No. 2. The condyle is prolonged beyond the neural arch, and much depressed. They may be dorsals which immediately follow the cervicals.

A fourth depressed vertebra resembles in miniature those first described as cervicals. Its proportions are rather those of a phalange, as described for both caudals and cervicals of some Pterodactyles, and are obviously procoelian; the inferior face concave, and the condyle-bearing centrum prolonged beyond the neural arch and slightly decurved.

	Lines.
Total length (No. 47),	5.
Length neural arch,	3.5
Depth anteriorly,	1.5
" at middle,	.75

No hypapophysis.

Views of eleven vertebrae from above are more or less complete, while many others are broken or not characteristic. Where the neural arch has not been destroyed a bifurcation appears at the extremity opposite the condyloid, which is probably the two extremities of the surspectant or anterior zygapophyses, which are separated by a deep notch. As they offer no trace of centrum above them, they are not probably the lateral inferior processes described by Owen. The great length of the diapophyses is especially characteristic of a Pterosaurian. These are either narrow, of nearly equal breadth (Nos. 23, 25, 26, 27); shorter and more dilated at the extremity (Nos. 31, 41) or still shorter, and with obliquely truncate extremities (20, 41). The last are similar to those figured by Von Meyer as the lumbars of Pt. longipelvis, and near them occur two bones, which can most probably be pubes. From a portion of matrix exhibiting the extremity of a slender diapophysis, with two ribs issuing below it, it might be supposed that they were rib-bearing, while one of the shorter and more spatuliform clearly bears the end of a rib.

	Lines.
Total expanse of No. 27,	14.25
Length centrum,	3.5
Width diapophysis at end,	1.1
Expanse No. 25,	14.5
Width diapophysis base,	1.75
" extremity,	1.5
Expanse No. 26,	9.6
Diameter neural canal,	1.

* Philosophical Transactions, 1859.

In the last the vertebra is broken obliquely away, leaving the condyle at one extremity and the bifid surspectant zygapophyses at the other, thus demonstrating their character. In No. 31 one face of the diapophysis is straight, the distal dilatation being occasioned by the expansion of the opposite margin.

	Lines.
Length of diapophysis,	6
Width distally,	2

At No. 20 there are four vertebrae in their natural succession, but separated and disarranged. There are no ribs near them.

	Lines.
Length body *a* (anterior),	4.5
" diapophysis *b* (from body),	3.
" " *c* "	5.

None of the vertebrae exhibit from the vertical view the breadth dependent on longitudinal alae from the zygapo. physes so common among the Lacertilia.

Of sections and views of the extremities of the vertebrae there are many. They show the form of the neural canal to have varied from vertically to transversely oval, and the neural arch to have been tectiform with plane sides, when the canal is large, as in cervical and dorsal regions; but to have been flat where the neural canal is transverse, as in the lumbar region. Of the former kind we have those with no, low, or elevated neural spines, and the centra depressed; of the latter kind the neural spine elevated, and the centrum compressed. This form, which Owen points out among the birds in the same region of Apetenodytes, occurs also, according to H. von Meyer, in the lumbar region of Pterodactylus longipelvis Myr. Three exhibit a nearly cylindric form. Measurements of one of the most compressed, from which no diapophyses proceed (perhaps lost):

	Lines.
Depth of centrum,	2.
Width "	1.5
Depth neural canal,	1.

A transversely fractured vertebra, without centrum and with short neural spine and long diapophysis, is perhaps a rib-bearing dorsal.

	Lines.
Depth centrum,	1.7
Heighth spine above canal,	3.
Of neural canal,	1.
Length diapophysis from axis vertebra,	5.8

There are remains of numerous long bones, but generally broken or uncharacteristic. The extremities when preserved are generally oval, without angles or processes. Some are so slender and straight, as to be probably referable to wing phalanges. Three others are characteristic; one of these is quite of the form of Pterodactyle humerus, having an extensive proximal ala, with the transverse extent greater than the longitudinal; a slender shank and two distal articular surfaces. This has belonged to a small individual; length only 7.6 lines. An equally characteristic element is the ulno-radius, most probably. This is a moderately slender bone, with two nearly equal concave articular surfaces at an extremity, which is slightly dilated. The other extremity has been more dilated, and of an elongate oval form, without irregularities, as far as the specimen shows.

	Lines.
Length,	14.
Width simple extremity,	2.5
" shank,	1.1
" cotyloid extremity,	2.

The cotylus bearing extremity is oblique, the cotyli being sub-lateral for a flexed articulation, as is always found to be the case with the wrist of the Pterosauria, as well as the Aves. This bone resembles no little the same element in another species, from Solenhofen.

There is in the private collection of Charles M. Wheatley, A. M., of Phœnixville, Pa., a specimen of two slender cylindric articulated rods, in a fragment of bituminous slate from the tunnel at that place. These have been already alluded to by Dr. Leidy* as probably indicating Pterosauria during this period, and though from a different bed from that at Gwynnedd, may have belonged to an allied species. They are strongly confirmatory of the characters adduced from the former. The phalanges have perhaps been second and third of a small individual, and neither are complete. The stouter measures 10.25 lines in length, and 1.5 lines in width at its slightly dilated proximal extremity.

The greater part of a femur occurs among the Gwynnedd specimens. It has been considerably enlarged at apparently the proximal extremity, where its section is subtrigonal, owing to a broad rising ridge with a shallow groove on one side. The distal extremity is compressed in a direction at right angles to the proximal, and is oval in section. No condyles preserved.

	Lines.
Length of part preserved,	16.
Diameter at proximal fourth,	2.25
" narrowest portion,	1.5

A phalange (No. 43) appears to have belonged to the foot of a larger individual than any whose bones are above identified. The proximal extremity is occupied by a cotylus; the distal follows immediately a constriction, and is curved slightly upwards, furnishing an extensive longitudinally oval condyloid súrface. It is immediately followed by a portion of a succeeding bone, which may have been the ungueal phalange. Length, 4.5 lines; depth at cotylus, 1.1 line.

Two pairs of elements I have regarded as pubes, though they are narrower than usual in Pterosauria, and nearly of the form of those of crocodiles. Their sizes differ, and are appropriate to the proportions of two individuals, to which other elements appertained. In both cases the pubes are parallel to each other and near together; their proximal extremities slightly dilated and concave; distal extremities much more dilated and convex. These are not diapophyses broken off, as they are more constricted medially and dilated distally. The longer pair lie closer to the series of vertebrae No. 20, which are sacral or lumbar, and have short, broad, and not dilated diapophyses.

	Lines.
Length of one of longer pair,	5.2
Distal breadth,	2.
Length of shorter,	3.5
Distal breadth,	1.5

A short element, with terminal divaricating limbs, which are equal to it, and to each other, resembles the furcula of Pterosauria from Solenhofen, and especially a similar element in the Megadactylus polyzelus. The limbs are not strictly symmetrical, which may be owing to the character of the fracture, or to pressure; it may, however, indicate that they are a curved pterygoid with divergent ectopterygoid at one side. Length of shaft 3.3 lines; of a limb, 1.75 lines; width of a slightly dilated extremity of the same limb, 1.4 lines.

Two similar pieces occur several times, which are of difficult interpretation. Each is subparallelogrammic with one nearly straight side; the extremity is entirely occupied by the mouth of a deep, narrow emargination, which is, therefore, bounded by two points, one of which is the longer. From the other side of the longer point projects a rounded quadrate portion, whose outline comes into that of the point; its other outline is opposite the angle of the emargination. Margin behind it broken.

If the preceding interpretations be correct, the genus Rhabdopelix had an elongate neck, with the long tail of

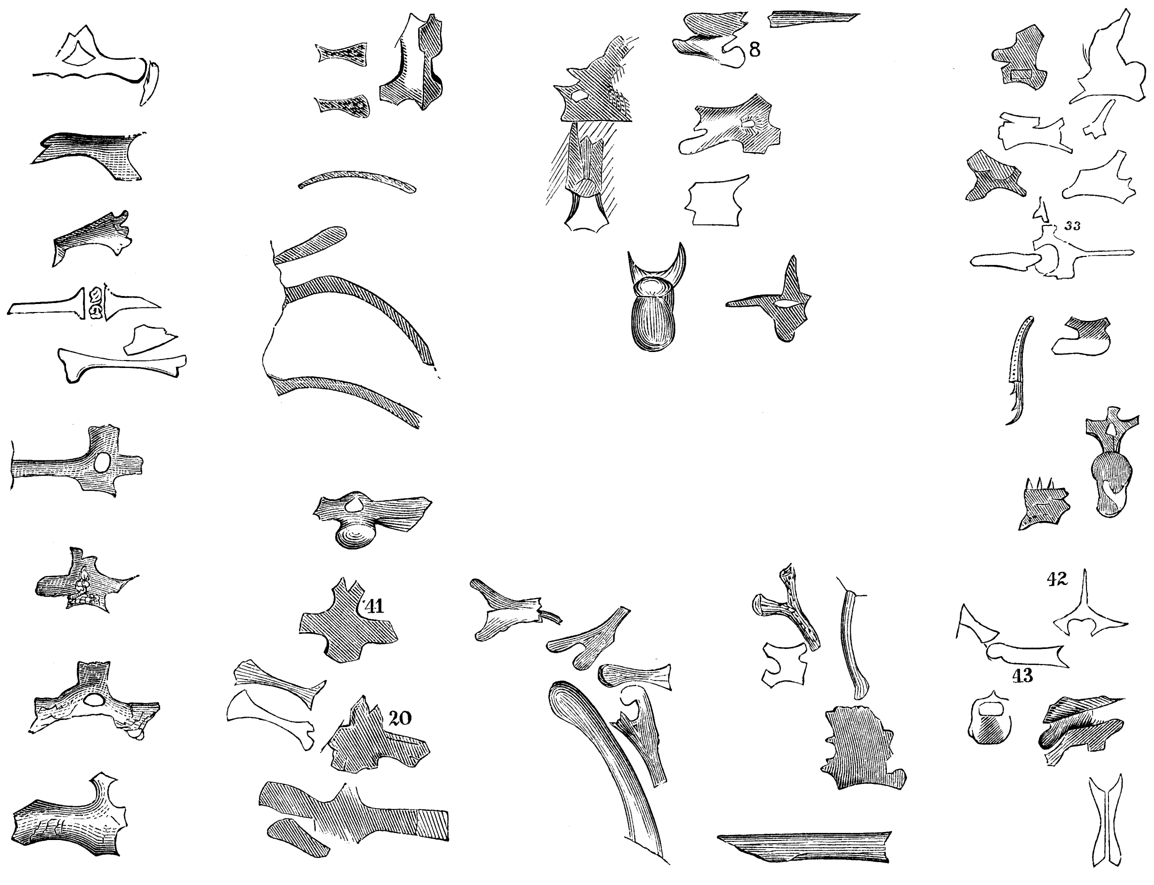
* Copied in Dana's Manual of Geology.

Archaeopteryx. Rhamphorhynchus, which most resembles it, differs in its simple teeth; and Dimorphodon, in its opistho- or amphicoelian vertebrae.

Dimorphodon Owen has been up to the present time the oldest type of the Pterosauria, D. macronyx Buck. occurring in the Lower Lias of England. The present species will therefore be of much interest, as originating in a supposed Triassic formation, but indicating with the Megadactylus more probably Jurassic age. Perhaps the strata continuous between its horizon and that of Belodon* (Be. carolinensis) will point to the correctness of Wheatley's† proposition, that "The true position may be determined like the San Casciano beds, intermediate between the Liassic and Triassic formations, and forming a separate group, containing like those beds its own peculiar fossils."

As the first Pterosaur found in the Mesozoic formations of North America, the species is of interest as indicating the future discovery of other forms of the same sub-class, which wide distribution will furnish additional illustrations or the persistency of evanescence of types. Some of the remains, however, probably belong to the Symphypoda.

Fig. 46.



PYTHONOMORPHA.

Cope Proceed., Boston Soc. Nat. Hist., 1869, p. 253.

The genus Mosasaurus, since the discovery of the large specimen in the St. Peter's Mount, at Maestricht, has been a subject of discussion by many palaeontologists, and ever

*Vid. Cope, Proceedings Academy, 1866. † In Silliman's Journal of Science and Arts, XXXII, 1861.

with unsatisfactory results. While Faujas believed it to be a crocodile, Camper and Cuvier regarded it as a lacertian, and placed it near the Monitor. In the latter relation it has been allowed to remain by Goldfuss and Owen, who have since written upon it, and so it continues to be regarded by all palaeontologists of the present day, who have expressed an opinion on the subject.

I have, however, been able to demonstrate, by the light of new material recently discovered, that the Mosasauridae and Clidastidae constitute a peculiar order of Reptiles, which possesses a combination of the characters of Serpents, with those of Lacertilia, and some others of the Sauropterygia. The reason why, as I conceive, this genus and its allies have been so little understood, has been a lack of analysis of the structure of portions of the cranium little known, as well as of portions better known, and the lack of certainty as to the structure of the limbs.

The characters of the order are as follows:

First. The teeth have no fangs.

Second. The opisthotic bone projects free from the cranium, and is the suspensorium of the os quadratum.

Third. There is no columella.

Fourth. There is no symphysis mandibuli.

Fifth. The parietal is decurved posteriorly, and extends to the ? sphenoid, forming the cranial wall in front of the proötic.

Sixth. The subarticular and splenial elements of the mandible are connected by articular faces.

Seventh. The vertebrae are very numerous, much exceeding one hundred, and frequently present the zygosphen articulation.

Eighth. The abdominal cavity is long and is surrounded by many short curved ribs, which have simple heads and a free antero-posterior movement on vertical articulating surfaces, and which commence close behind the axis vertebra.

Ninth. The pterygoids are elongate and bear numerous teeth, and in one type are free except at the extremities.

Tenth. The brain case is not fully ossified anteriorly.

Eleventh. Scapular and coracoid elements are present.

Twelfth. The caudal vertebrae are furnished with chevron bones.

Thirteenth. The squamosal bone is present.

Fourteenth. The angular bone is distinct.

Fifteenth. The os quadratum is moveably articulated to the opisthotic.

Sixteenth. The os quadratum embraces and encloses the meatus auditorius externus.

Seventeenth. The opisthotic is supported by a pedestal projecting from the cranial

walls, composed of the prolonged proötic in front, and the exoccipital behind, which embraces the suspensorium for much of its length.

Eighteenth. The anterior limbs are fins, with all the elements in a single plane; the radius incapable of rotation; the humerus broad and flat.

Nineteenth. There are probably no hind limbs.

Of the above characters the first eight are those of serpents; the five characters following the ninth are lacertian, while the seventeenth is peculiar, and not found in any existing order of reptiles. The eighteenth is characteristic of the Sauropterygia.

The characters of the teeth are much those of serpents, and much more different from those of any Saurians. As without true dentinal fangs, they are serpent-like; for the ossification of the pulp, which produces a fang-like support to the crown, is not more than a subordinate character, like that of ossification or non-ossification of cartilages in many existing orders. The pterygoids, which are in contact medially in Mosasaurus, are largely free in Liodon and in Clidastes; in the latter they bear teeth as abundantly as do many serpents. Among the Lacertilia the dentition is either truly rhizodont (the Acrodonta) or Pleurodont. The teeth of the Varanidae are especially different from those of the present order, and present only a modification of the pleurodont character. The outer parapet of the jaw is low, and the shanks proportionately short; they are in addition more expanded than in most other pleurodont families.

The characters preserved by the temporal region are highly peculiar and important in determining the affinities of the group. The discovery of its structure furnishes the desired explanation of sundry enigmatical bones which occur not unfrequently in our Cretaceous formations. In the following diagnosis the present is compared with the three orders to which it makes nearest approach.

Testudinata.

Opisthotic distinct, closely united with exoccipital squamosal and proötic, and supporting squamosal and quadratum.

Lacertilia.

Opisthotic distinct, closely attached to parietal arc, and at extremity to exoccipital and proötic; supporting squamosal and quadratum.

Pythonomorpha.

Opisthotic distinct, not or scarcely in contact with parietal arc; embraced at one end by proötic and exoccipital, and supporting squamosal and quadratum.

Ophidia.

Opisthotic distinct, attached only to proötic, and supporting only quadratum.

There can be no doubt that the suspensorium of Mosasaurus is homologous with the element in the tortoises called by Huxley opisthotic. It appears, also, to be homologous

to, and analogous with, the suspensorium of the Ophidia; hence I conclude that the latter bone is the opisthotic, and not squamosal, as given by Huxley (Elements Compar. Anatomy); and the more, as it co-exists with a true squamosal in these extinct reptiles. Internally it forms a very small or no part of the wall of the cranium, but is a solid plug between the embracing laminae of the proötic and exoccipital. The two latter bones are therefore unusually and peculiarly prolonged outwards, and unite by thin edges on both the upper and inferior faces of the suspensorium. The fenestra ovale is at the base of the infero-posterior face of the latter, and enters an exceedingly small vestibule. The fenestra rotunda is immediately below it, and is funnel-shaped, with a small orifice. In the small development of the auditory apparatus it is again like the serpents.

The mandibular arch is very much like that of serpents. The lack of symphysis gave each ramus the independent motion which they possess in the Ophidia. The articulation of the splenial and subarticular is a character not seen in any lacertian, but is highly characteristic of the Boaeform Serpents of the genera Loxocemus and Eryx, though it does not occur in Boa proper, nor in many other serpents. This has allowed of some motion as the bones of the ramus above it are merely united by a squamosal suture, and the dentary terminates abruptly between a sheath of the coronoid, etc. This termination, with the articular faces of the inferior elements, are characteristic of fragments not uncommon in the Cretaceous beds, and which have never in this country been referred to their place. The coronoid bone also is developed only as in the few serpents that possess it, as Eryx, Xenopeltis, and Boa; Goldfuss notices its great anterior prolongation and curvature, and overlapping of the extremity of the dentary. Finally the obtuseness and abbreviation of the angle of the jaw is Ophidian—rarely lacertian. The distinctness of the angular bone is on the other hand a lacertian feature.

The postero-lateral margin of the parietal is decurved and is connected to the sphenoid by a lateral plate of bone, which is united suturally to the latter. I have been unable to find in Clidastes any suture indicating that this piece is an alisphenoid, rather than the parietal; it appears to belong to the latter bone. If so, it is a strong Ophidian character; if it be alisphenoid, it is Chelonian and Crocodilian; no Lacertilian presents a like structure.

In the genus Clidastes the pterygoid bones are distinct except at their anterior extremity, and bear a long series (17 *e. g.*,) of teeth, resembling thus the serpents.

The vertebral column resembles in many features that of the serpents. It is longer, and contains more numerous vertebrae than Lacertilian or Saurian types, and has therefore a much more slender form than they. The ribs are cylindric, as in lizards and serpents, and are present throughout the long dorsal and lumbar series of vertebrae, forming a much longer series, and embracing a more Ophidian visceral cavity than is seen in

the other Reptilian types. An important section of the order possesses the zygosphen articulation. This is universal in the Ophidia, and exists in one family of the Lacertilia, the Iguanidae. In the former order it is placed at a considerable elevation above the zygapophyses, while in the latter family it is nearly in the plane of the zygapophyses, thus occupying a lower position. The structure in the Pythonomorpha is of the latter character. In species intermediate between this form and the more simple one in the orders, the zygosphen is found in a rudimental condition.

The diapophyses present the vertical costal articular face of Ophidians and Lacertilians. The immensely long tail, used as a powerful swimming organ, is in truly serpentine proportion, while its chevron bones are a lacertian rather than ophidian character.

The proötic extends from the basioccipital to the parietal, and overlaps the latter by its superior anterior margin. This does not occur among Lacertilia except in aberrant forms, but is common to all serpents. There is a strong superior and anterior ala on the sphenoid, which furnishes part of the suture.

The ribs are cylindrical throughout much of their length, and resemble those of the Boas in their articulation by a compressed vertical head to a vertically compressed diapophysis. There is no attached parapophysis as in the serpents.

With respect to the characters in which this order is identical with the Lacertilia, the following observations may be made.

The brain case appears to be unossified anteriorly, as in Tortoises, Crocodiles, and Lacertilians; and the parietal, both descends as in Testudinata, and the ali-spenoid ascends, as in Crocodilia.

The extensive union of the o. o. palatina and maxillaria is a character of Lacertians and other Saurian orders, and the existence of separated hypapophyses is a feature seen in a few existing Lacertilians. These separate elements are articulated to heavy cylindric fixed hypapophyses, which are characteristic of the cervical vertebrae of this whole group with the exception of one genus. Though the separation of the extremital pieces is Lacertilian, they are in the latter sessile, and the great length of the whole hypapophysis paralleled by those of the serpents.

The scapula and coracoid are not very different from those of Lacertians, and are not coalescent. The scapula appears to have had an angle or process similar to the procoracoid, while the coracoid is entirely without the emarginations common to Lacertilia. No trace of claviculus, mesosternum or xiphisternum has been found. On the whole, the scapular arch is quite as similar to that of the Sauropterygia as that of the Lacertilia.

The os quadratum is like that of the Lacertilia in its form, and in its support by two suspensoria. It is as mobile, but much shorter than, in the serpents, and differs from that of both these orders in nearly enclosing the meatus auditorius behind by a large decurved

process. In this, these animals resemble the Testudinata, but in this only, for it is not attached to the proötic in front as in them. In all the species of the order I have seen, it is characterized by the presence of an oval pit, with mouth making a strong angle with the surface. It is situated just in front of, sometimes within the margin of, the meatus auditorius externus. Its use is uncertain, but there is some probability that it received the extremity of an osseous or cartilaginous styloid stapes. A groove on the under side of the suspensorium would accommodate such a rod, and in a position nearly similar to that which it occupies in many of the Ophidia. Nevertheless its extremity would have to be a little recurved in order to enter the pit in question.

In both families of the order there is a zygomatic or squamosal arch, but it is very doubtful whether any malar arch exists. There is no connection by malar or quadrato-jugal posteriorly.

The chevron bones of the caudals, as is well known, are highly developed. They resemble those of some Saurians. This is an important character, for these elements do not exist in the Ophidia, where hypapophyses takes their place. A structure somewhat resembling the latter, seems to exist in Elasmosaurus.

The parietal fontanelle is similar to that seen in Lacertilia and Sauropterygia.

The six characters in which it resembles the Lacertilia are shared by at least one other order of Reptiles. In its lacertilian characters it approaches nearest the Varanidae, which themselves offer some approximations to the Ophidia. The elongation of the proötic anterior to the internal ear is a character of all the slender-tongued lizards, and the long superior nostrils and lack of malar arches belong only to the Varan .

The singular manner in which the opisthotic is supported is only paralleled, so far as I am aware, by the Ophidian family of the Tortricidae, where it is similarly projected from the grasp of the proötic and exoccipital, as suspensor of the quadratum. In Cylindrophis the parietal and part of the supraoccipital enter the connection also.

With reference to the limbs, Cuvier says, " that very few bones of the extremities of Mosasaurus have been found, and their rarity was such that, for a moment, he was led to doubt whether the animal possessed limbs." He states that he was soon undeceived by recognizing a bone of the pelvis which certainly belonged to Mosasaurus. The bone considered to be a pubis, resembling that of the Monitor, as figured in the Ossemens Fossiles. Cuvier further says, that among some fossils from Seichem he detected a scapula resembling that of the Monitor; and subsequently received drawings from Maestricht of a clavicle resembling that of a common Lizard, and also a coracoid bone. From the specimens and figures Cuvier supposes the shoulder of the Mosasaurus to have exhibited a close resemblance to that of the Lizards. After remarking that he had been unable to procure any long bones of the limbs of Mosasaurus, he expresses his views in regard to certain

figures of bones, represented by Faujas Saint Fond and Camper, reproduced in the Ossemens Fossiles. In regard to the figure of a portion of an ulna, Cuvier says, that if the bone belonged to Mosasaurus, it would indicate the extremities to have been moderately elevated. But he continues, the bones of the feet, so far as they are known, appear on the contrary, to have belonged to a sort of a contracted fin, as in the Dolphins or Plesiosaurus. Of the different bones of the feet, figured in the Ossemens Fossiles, after Camper, Cuvier likens some of them to the principal carpal bones of the Crocodile, another appeared to belong to some huge Saurian, some are phalanges, and two are attributed by him to Turtles, whose remains are not less common in the deposits containing those of the Mosasaurus. In conclusion Cuvier adds that, "it was not without hesitation that he expressed the conjectures from mere figures, when the immediate comparison of the bones themselves would scarcely suffice, so great is their diversity and so small the precision of their forms in reptiles."

Goldfuss describes and figures several bone fragments from the deposits of the Cretaceous period of the Upper Missouri, which he views as the portion of a scapula, a coracoid bone, and an olecranon process of the Mosasaurus. In relation to the habits of the animal, he says, as it lived in the ocean the toes no doubt were webbed, but the remains which have been discovered, on the contrary, do not lead to the supposition that it possessed fins like Ichthyosaurians. Prof. Owen, after remarking that no part of the organization of the Mosasaurus is so little known as that of the locomotive extremities, and substantially quoting the views of Cuvier, expressed above, enters into the description of some long bones of the extremities, "showing the Lacertian type of structure," which were obtained in the Green-Sand formation of New Jersey. Prof. Owen says, "on the highly probable supposition that these bones belong to the Mosasaurus, they indicate the extremities of that gigantic Lizard to have been organized according to the type of the existing Lacertilia and not of the Enaliosauria or Cetacea." Pictet says the humerus of Mosasaurus is thick and short, like that of Ichthyosaurus, but gives no evidence for this assertion. He adds, we may conjecture, from the flattening of the bones of the members, that the feet were probably converted into fins like those of the Enaliosaurians.

Schlegel states in one of the older numbers of Leonhard & Bronns' Jahrbuch der Geologie, etc., that the anterior limbs are paddles, adapted to an aquatic habit.

Finally, Leidy (Cretaceous Reptiles, 42,) states that "remains apparently of Mosasaurus which I have the opportunity of examining, indicate the limbs to have been fins, partaking in their structure of the characters of those of the marine turtle and the Plesiosaurus."

There can be no doubt that the above authors have correctly assigned such limbs to the two species that came under their observation; and I add the evidence derived from

another species of Mosasaurus, and from one of Clidastes, as entirely confirmatory of it. On the other hand, I am unable to assign hind limbs to any of the species of the order. The anterior limbs combine the characters of Testudinata and Sauropterygia. The ulna and radius, and all more distal portions of the limbs, are those of the latter order. The large ovoid flat carpals, and flat, medially contracted phalanges, with fixed articulations, are of that type. Three of such phalanges have been figured by Leidy, Cret. Rept. VIII, figs. 6 and 7, where they are regarded as radii, and at fig. 13, Pl. XVII. Ulna and radius are figured Pl. VIII, figs. 9 and 10.

From the preceding evidence, we may look upon the Mosasauroids and their allies as a race of gigantic marine serpent-like Reptiles, with powers of swimming and running like the modern Ophidia. Adding a pair of short anterior paddles, they are not badly represented by old Pontoppidan's figure of his sea serpent.

That their habit was to devour whole is evident, and though the articulation of the lower jaw will not admit of as much extension as that of the Ophidia, it exceeds other reptiles in this capacity, allowing by its lateral flexure, of the passage of large objects between the rami. The carnivorous Dinosaur on the other hand, tore his prey to pieces, as do Mammals of the present day.

Thus in the Mosasauroids we almost realize the fictions of snake-like dragons and sea serpents, in which men have been ever prone to indulge. On account of the Ophidian part of their affinities, I have called this order the Pythonomorpha.

The families embraced are two, the Mosasauridæ and Clidastidæ, which differ as follows:

Vertebræ with zygosphenal articulation wanting or rudimental; humerus free in life. MOSASAURIDÆ.

Vertebræ with zygosphenal articulation developed; humerus probably included in life. CLIDASTIDÆ.

In time they immediately preceded the Eocene Palaeophides, and probably will find in them distant structural allies.

I think it highly probable that the genus Saurospondylus of Seeley, from the lower chalk of England, belongs to this order. If so it is the type of a peculiar family, to be known by the absence of neural spine and low position of the zygapophyses, which have horizontal articular faces. The S. dissimilis, Seeley, is a much smaller animal than any here enumerated, and is known by a single vertebra.*

Goldfuss states that Mosasaurus possesses a malar arch. This is absent in Clidastes, and I am inclined to doubt whether Goldfuss has demonstrated his point; if present, it must be as he states, very slender.

* See Ann. Magaz. Nat. Hist., 1865, Sept.

MOSASAURIDÆ.

Dentition. In this family the forms of the teeth differ in different parts of the maxillary bones. Those on the premaxillaries are more cylindric in section, and the compression, or development of angles or facets, whichever it be, increases as they succeed each other posteriorly. One peculiarity characterizes the teeth of the most of the true Mosasauri, viz: the anterior aspect bears a cutting edge more or less developed, while in Liodon the posterior is more strongly developed.

Os Quadratum. The superior extremity of the os quadratum appears to have had considerable motion on the opisthotic. Its extent is so much greater than that of the cotyloid or glenoid cavity applied to it, as to suggest a gliding motion, especially as it constitutes an extensive arc, possessing grooves of attachment for articular cartilage throughout its length. This arc is, however, bent or curved in the horizontal plane, which would result in a twisting of the os quadratum round its long axis, should the motion I suggest have taken place. Such a twist would throw the proximal portion of the ramus of the jaw outwards, a motion quite necessary to the horizontal flexure of the ramus at the splenial articulation, which no doubt took place in swallowing any large object. The extent of this outward deflexion of the articular, coronoid, etc., portions of the jaw, was measured by the outward concavity of the proximal end of the quadratum. Thus this is least in M. depressus, and greater in M. dekayi and M. maximus (see cuts fig. 48); the great projection of the external angle in Liodon validus, gave that species an excessive power of dislocation, and the same peculiarity in Clidastes propython, was followed by the same effect.

As the development of processes and ridges on the ossa quadrata differ in the different species, they may be named as follows: The proximal articular surface extends over the *external angle*, and over the upper edge of the ala forming the *alar process* (see cuts). Below the meatus and knob, on the postero-external margin, there is a ridge which terminates in a process in some species, to be called the *median posterior ridge.* In some a ridge rises from the outer angle of the distal articular face, extending outside the ridge just mentioned, towards the pit, called the *distal external longitudinal.* In front of this, on the outer face of the quadrate behind or near the origin of the ala, may be a ridge called the *external ridge.* See Tab. XI, figs. 6–7.

Vertebræ. As has been already pointed out by Cuvier, the vertebræ in this genus fall into cervical, dorsal, sacro-lumbar and caudal series. The cervicals are either round or depressed in this genus; in Liodon the articular faces are either round or compressed in the species I have examined. They are arbitrarily characterized by the presence of an obtuse hypapophysis which has an articular surface for a separate continuation of the same, as in Clidastes. None of these pieces have come under my observation in this

genus, but one is probably figured by Camper (Tab. 248, fig. 21 of Cuvier Ossem. Fossiles), which Cuvier says is perhaps an ungueal phalange. The dorsals have no hypapophysis, and the diapophyses decrease in vertical extent towards the posterior part of the series. The greatest variation is presented by the different species in the long series preceding the caudals, which do not present zygapophyses. The posterior of this series are much shorter than the anterior, the former having the form of the dorsals, the latter of the caudals. In the M. dekayi, M. gracilis and M. giganteus, none of these are depressed; the shorter are subpentagonal in section; in M. depressus and M. missuriensis the longer are depressed, while the depression of the shorter diminishes regularly to the distal caudal series. In M. brumbyi the long vertebræ are flattened to a still greater degree. (See Gibbes' Mongr.)

The caudals are divided into three series by Cuvier, viz: those with separate chevron bones, those where the latter are united to the centrum, and those without them. Passing posteriorly these vertebræ become gradually shorter and more vertically ovate in form. The more posterior are less narrowed in the M. maximus, M. oarthrus and M. missuriensis (vide Leidy's work), while in M. dekayi and the Liodons they are rather more narrowed vertically.

The characters of the diapophyses are marked in different parts of the column. In all the species of the family they descend from an elevated position on the cervicals and anterior dorsals to an inferior one on the lumbars. They nevertheless never spring from the neural arch, as in the Archosauria, but always from the base of it. On the median dorsals it originates from the middle of the side of the centrum, and on the lumbo-sacrals from the plane of the inferior surface. It diminishes in size, and as soon as the articulations of the chevron bones appear, begins to ascend again. On the anterior caudals it rises to near the middle of the centrum and gradually disappears, at different points in the different species.

The chevron bones are free throughout the anterior part of the caudal series in the M. giganteus, and confluent with the centrum in the posterior portions. This is probably the case with many species of the genus. During immaturity they may be all distinct in Mosasaurus, and in the genus Liodon (vel *Macrosaurus*) this condition is permanent throughout life, and so characteristic. This is indicated by the very large individual typical of L. proriger, and is visible in two other species of the genus.

Genera. The four genera below enumerated appear to differ in tangible characters. These are found in the relations of the pterygoid bones and teeth, and characters of vertebræ. A number of genera have been proposed on minor modifications in the forms of the teeth. These are *Liodon*, Owen, *Holcodus*, Gibbes, and *Polygonodon* and *Pliogonodon* of Leidy. The very close similarity in dental characters among the members of this

group, and indeed in any group where they are characterized by such simplicity of form, renders it probable that there will be found a complete gradation between different genera in this respect.

I. Cervical vertebræ with separated articulating hypapophyses.
  Pterygoid bones united on the middle line.
    The pterygoid teeth pleurodont. PLATECARPUS.
    The pterygoid teeth in alveoli. MOSASAURUS.
  Pterygoid bones vertical, separated throughout their length. LIODON.

II. Cervical vertebræ with simple continuous hypapophyses. BAPTOSAURUS.

Two genera have been defined from dental characters, as follows:

Crowns of the teeth curved, with one face smaller than the other, more or less attenuated and acute; numerous narrow ridges on inner face. HOLCODUS.

Crowns of the teeth straight, compressed, more slender, regularly acuminate; faces equal, facets distinct, numerous. POLYGONODON.

The genus Diplotomodon, Leidy, known from a single very much compressed dental crown with minutely denticulated edges, may belong here.

To what extent and in what manner the dental characters of those genera established on them, coincide with those distinguishing the genera of the table, it is not now easy to discover. In species referable to *Macrosaurus*, teeth of the compressed form and lenticular section characteristic of Liodon, are found in one species, while another presents the more angular facetted section of Mosasaurus in the anterior portion of the series. Both forms seem to occur in Mosasaurus proper, according to Leidy. Of these genera founded on dental forms, Polygonodon, Leidy, is the best marked, and will prove distinct from any of the above.

The humerus of a very large reptile in the Mus. Acad., Phil., has been regarded by Agassiz as belonging to a Chelonioid, and by Leidy been referred to the common Mosasaurus of New Jersey. There is at present no means of assigning it to any species of this order otherwise defined. It is the *Atlantochelys mortoni* Agass., and may refer to any large species of the genus so far as our knowledge goes; it was not originally described, however, and cannot therefore retain this name. The *Mosasaurus dekayi*, Bronn, is founded on a tooth exactly like that of *M. mitchillii* of Leidy, and cannot be distinguished on such basis alone. The *M. impar* is only known from jaws and teeth, and hence is the only species whose name is liable to have been duplicated here. It may belong to any of the American species of Liodon here enumerated, except *L. validus* and *L. proriger*, whose

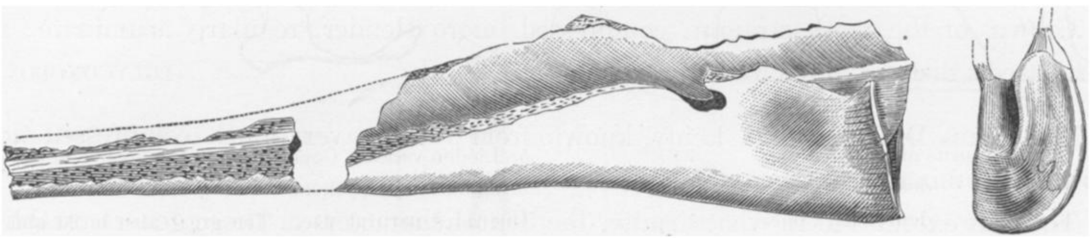
teeth are well known. As it has probably been earlier named M. mitchillii by Dekay that name will remain attached to it.

The *Elliptonodon compressus*, Emmons, I do not consider to be a Mosasauroid. The *Baseodon reversus*, Leidy, is founded on pterygoid teeth of some species. They resemble those of M. *dekayi*.

MOSASAURUS, *Conybeare*.

In this genus, the median articulation of the ramus mandibuli permitted of much less motion than in Clidastes, and probably allowed of only a moderate expansion of the interramal space. That it permitted the deglutition of very large bodies is apparent. The accompanying cut exhibits the posterior splenial articular face in two views, of a large M. dekayi from Gloucester Co., N. J.

Fig. 47.



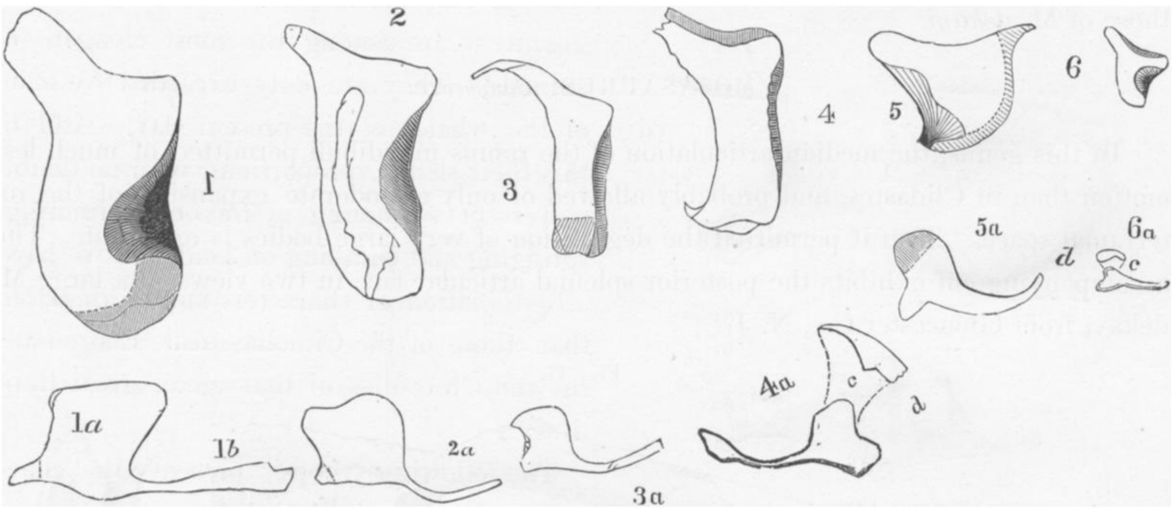
There are numerous species of this genus, which appear to belong to two groups, the one characterized by the rounded, and the other by the depressed form of the lumbar vertebræ. A species of the latter type has been referred to the genus *Amphorosteus* by Gibbes. They however seem to graduate into each other through such species as M. missuriensis, in such a way as to preclude the idea of the existence of distinction on that ground. The teeth, as has been shown by Leidy, present a considerable range of variation, which, he remarks, if too great to be embraced by a single species, indicate a greater number of species than has been supposed.

Having access to a considerable amount of material, contained in the cabinets of the Academy Natural Sciences, the State Geological Survey at New Brunswick, of the Mount Holly (Burlington Co.) Lyceum, and of myself, I can rely with confidence on the existence of seven species of the restricted genus. These are, M. maximus, Cope, M. dekayi, Bronn, M. fulciatus, Cope, M. missuriensis, Harlan, M. oarthrus, Cope, M. depressus, Cope, M. brumbyi, Gibbes. As a species probably distinct, but not well established, I include M. minor, Gibbes.

Cranium. The species named, as well defined, have been compared in their quadrate bones, atlases, and lumbar vertebræ, where the most marked peculiarities have been dis-

covered. In the following cuts the outlines of the proximal extremities of the ossa quadrata are given, with sections at a little below the middle of the length of each.

Fig. 48.



1. Mosasaurus maximus, Cope.
2. " dekayi, Bronn.
3. " depressus, Cope.
4. Platecarpus tympaniticus, Cope.
5. Liodon validus, Cope, position the reverse of the others.
6. Clidastes propython, Cope.

One-third natural size. The great alae in 2a and 5a are unknown.

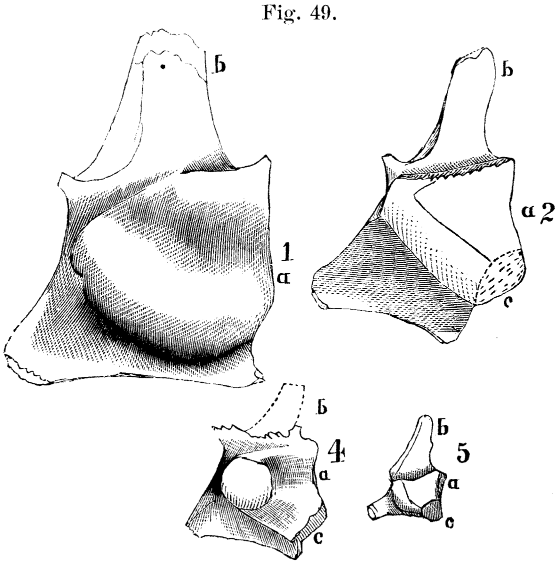
b, the great ala; *c*, the meatus auditorius; *d*, the posterior decurved extremity of the proximal end of the os quadratum.

Dotted lines crossing the outlines indicate fractures and restorations outside of them. In figs. 4a and 6a the dotted lines indicate the bridging of the meatus by the proximal extremity of the bone. The great ala is lost in our specimens both of M. dekayi and M. depressus. The marked peculiarity of M. depressus is shown above; also, the great decurvature of the superior extremity around and behind the meatus in the Platecarpus and the Clidastes. In them it descends below opposite the point of section, and is therefore divided by the line from which the outline is taken. In Mosasaurus minor, gracilis, and brumbyi, the quadrate bone is unknown.

Vertebræ. The outlines of the lateral elements of the atlas of five species, including that of the giganteus, (from Camper) indicate corresponding differences, which are most distinct on the internal faces. In M. giganteus, M. depressus, and M. dekayi there is a facet for articulation with the centrum, just below the anterior facet. In order to accommodate this, the inferior ala ceases behind the anterior facet in the last two species, or is only developed at the posterior part of the element in the European animal. In the M. maximus, on the contrary, this ala is prolonged to, and even beyond the anterior or

condyle-meeting facet, leaving none whatever for union with the centrum. I, therefore, suppose that in that species these elements were barely in contact.

Fig. 49.



1. Mosasaurus maximus, Cope.
2. " dekayi, Bronn.
4. Liodon validus, Cope.
5. Clidastes propython, Cope.

One-third natural size, except fig. 4 one-fourth (?), and 5, one-half. *a*, anterior articular surface for occip. condyle; *b*, neural arch; *c*, articular face for centrum.

The giants of the order belong here, for the M. missuriensis, M. maximus, and M. giganteus are among the most elongate of animals. They are only exceeded by some of the whales of the present day. Add to this their slender proportions, with no doubt, powers of swimming in the ocean, running, springing and climbing on land, and we have a combination of characters more formidable than those of the Cimoliasaurus, Elasmosaurus and Crocodiles of that age of great Reptiles.

The following synopsis presents the characters of the species in brief:

I. Vertebral centra with subround articular faces.

α A short ridge on the outer posterior angle of the os quadratum.

β The anterior caudals with circular articular faces;

Quadrate bone with large alar and large proximal external angular articular surface; meatal knob rudimental; a strong median posterior ridge become a process; a short, strong distal external longitudinal angle; very large teeth; (? 17—)18. M. MAXIMUS.

Quadrate bone with small alar articular surface and large meatal knob; external proximal angle large; median posterior ridge rudimental; mandibular teeth 17: very large. M. PRINCEPS.

ββ The anterior caudal vertebræ with subpentagonal articular faces;

Quadrate bone with moderate alar and angular surfaces proximally; knob small, median posterior ridge rudimental; distal external longitudinal angle elongate; mandibular teeth, fourteen; maxillaries, eleven; pterygoids eight, moderate; large. M. GIGANTEUS.

Quadrate bone with small alar and large external angular proximal articular surface; meatal knob large, median posterior ridge rudimental; exterior distal longitudinal angle a raised acute ridge; no external alar ridges; premaxillary teeth, four; pterygoids subequal, less than half as large as mandibulars; large. M. DEKAYI.

αα An elongate ridge on the outer posterior angle of the os quadratum;

Quadrate bone with small alar and small external angular proximal articular face;

meatal knob, and median posterior ridge both large; a strong distal external ridge, embracing with latter, an elevated rib, to the pit. ?Teeth. Medium. M. FULCIATUS.

aaa ?Quadratum; caudals pentagonal;

Mandibular teeth twelve, spaced, (Owen); smaller. M. GRACILIS.

II. Centra of cervical, dorsal, and lumbar vertebræ, transversely oval.

a Large species; the centra of posterior dorsals not keeled from diapophyses to the cup.

β An external alar angle from distal extremity to meatus;

Meatal pit within meatus; proximal articular face little curved, with long and narrow branch on edge of convex ala. M. DEPRESSUS.

ββ No ribs on the external face of the ala of the quadrate;

Vertebræ but slightly transverse; quadrate with small alar and angular articular surface; meatal pit external; knob very large, separated by a deep groove from very prominent median posterior ridge; external distal longitudinal ridge rudimental or wanting; large. M. OARTHRUS.

Mandibular teeth fourteen; pterygoid ten; squamosal with broad triangular expansion above opisthotic. Quadrate bone longer than broad. Dorsals transversely ovate, sides rounded. M. MISSURIENSIS.

aa Large species, the dorsals flattened, with lateral keel on side;

Diapophyses in front of middle of centrum; M. BRUMBYI.

aaa Small species with depressed centra.

Centra transversely ovate; caudals vertical ovate; M. MINOR.

MOSASAURUS MAXIMUS, *Cope.*

Proceed. Bost. Soc. Nat. Hist., 1869, 262.

A portion of an individual from the lower green sand bed of Monmouth Co., N. J., has been submitted to me by the Director of the Geological Survey of the State, Prof. Geo. H. Cook.

It consists of a nearly perfect os quadratum, several dorsal and cervical vertebræ, including axis and atlas, with numerous elements which have been scattered and have not yet come into my hands. The remains indicate an animal of the largest size.

The quadrate bone compared with those of two other species from the New Jersey Green Sand presents marked characters. Four quadrate bones of the *M. dekayi* exhibit such constancy in the form, as was to have been anticipated, while in the M. maximus and M. mitchillii, it is an obtuse angle and that over the ala a process, which is very large in the former, and small in the latter. The knob just within the meatus of the ear is very prominent in the *M. depressus* and *M. dekayi,* while it is rudimental in *M. maximus:* in the latter the outer ridge bounding the meatus is

* MOSASAURUS GIGANTEUS, *Soemmering.*

Lacerta gigantea, Soemmering. *Mosasaurus hoffmanii*, Mantell. *M camperi*, Meyer. *M. belgicus*, Hall.

Upper cretaceous Belgium, Rhine Prussia and England.

MOSASAURUS GRACILIS, *Owen.*

British Fossil Reptiles Tab.

Upper cretaceous England.

prolonged into a process below, which is merely rudimentary in the two species named. The centra of the dorsal vertebræ are very cylindric, and shortened antero-posteriorly. In an anterior, with diapophyses directed obliquely upwards, the centrum is very convex in cross-section beneath and the articular faces are a little deeper than wide. In more posterior dorsals, with diapophyses at the middle of the centrum, the inferior convexity is also very strong. The articular ball is subpentagonal in outline, its lateral margin being remarkably prolonged forwards towards the basis of the diapophysis. This form prepares us for subpentagonal lumbars such as characterize several species of the genus.

The hypapophysis of the axis is very stout, occupying its whole inferior surface; its articular face is half as large as the ball of the centrum, its posterior margin extending as far as the line of the edge of the ball. The latter a little broader than deep. That of the seventh to ninth cervical is more nearly round. The diapophysis of the latter has a triangular section, a plane face being anterior, and angle, posterior.

	In.	*Lin.*
Length of (7th, 8th or 9th ?) cervical,	4	10.5
Width ball,	3	
" neural canal,		10
Expanse of diapophyses,	7	5
Length neurapophysis of atlas,	4	
" of a median dorsal,	4	
Width ball of do.,	3	5
Depth do. do.,	3	2
Length of os quadratum,	7	6
" proximal articular face,	5	2
" distal "	5	
Width proximal extremity—greatest,	2	1
" " " —least,	1	5
" great ala at middle (within),	2	8

This animal, if the measurements of the Kansas specimen are to be relied on, must have reached a length of seventy feet.

Portions of an individual of similar proportions are preserved in the Cabinet of the Burlington Co. Lyceum, which were found in Gloucester Co., on the farm of David B. Coles. They consist of two cervicals, five dorsals and three caudals. Those of the first two series resemble those of the Monmouth Co. individual exactly, while the caudals furnish important additional characters. The latter are furnished with coössified chevron bones, and their diapophyses are situated a little above them, and have an oval section. The articular faces are more nearly round than in some other species, *e. g.* M. dekayi, and are as deep as wide, with but a slight truncation on the upper external outlines.

	Lines.
Length centrum,	33.5
Depth ball,	36.7
Width do.,	39.

A more posterior caudal of an individual of the same size, in the Museum of the Acad. Nat. Sciences, is smaller, and exhibits diapophyses at a slightly higher position, and more cylindric. Its proportions are quite similar to those of the caudal measured above. From this cause I am disposed to think that this species may have had sub-round, or very slightly compressed caudals, far posteriorly in the series, as in M. missuriensis. See the measurements of the corresponding vertebræ of M. dekayi.

The remains of a still more gigantic individual of this species were submitted to me by Dr. G. J. Fisher, of Sing Sing, New York, in whose possession they now are.

The bones were obtained through the efforts of P. R. Brinckerhoff, of Westchester County, N. Y., in the latter

part of the month of April, 1860. They were found on the farm of Geo. W. Crawford, at a place called Nut Swamp, three miles South of Middletown, Monmouth County, N. J. They were first discovered on opening a ditch through a meadow in Nut Swamp; G. W. Crawford being an intelligent farmer, took immediate measures to prevent their disturbance or injury, by having them protected until he could inform P. R. Brinckerhoff.

Accordingly, on the last week of April, P. R. Brinckerhoff succeeded in obtaining from this locality the portions of bones described.

They were all found at a depth of about four feet below the surface, and within an area of a few square feet. The bones were imbedded in wet marl, which contained an abundance of most of the fossils peculiar to the formation, as Gryphæa, Exogyra, Terebratula, Belemnites, &c. Near this spot, about fifteen years ago, considerable portions of the bones, but more particularly the vertebræ of the Mosasaurus, were found by J. M. Smith and Lyell Conover.

The portions found were so detached and diffused, as to afford no hope of obtaining much more of the skeleton without very extensive and expensive excavations, and it was with extreme difficulty that P. R. Brinckerhoff, by the aid of one or two men, and by one-and-a-half days' labor, succeeded in procuring the present specimens. There was a constant influx of water into the trenches, and the bones were very fragile.

The bones obtained, consist of large portions of the inferior maxillaries, with twenty, more or less, perfect specimens of full grown teeth, and several successional teeth,—with a posterior dorsal vertebra.

Drawings were made directly from the specimens.

The largest fragment found is a portion of the left inferior maxilla. It measures twenty and three-fourths inches in length; at the broadest extremity it is about seven inches deep, at the small extremity it is five inches; the upper or alveolar portion of the jaw is generally about three and one-quarter inches thick; the lower margin is quite uniformly two inches thick. This mass was considerably fractured in removing it from its bed, as is seen in the plate.

It contains the roots of three teeth, two of which have most of their enamelled crowns attached. The space between the first and second tooth is three inches. The space between the second and third teeth is two and three-fourths inches.

The roots of all the teeth are somewhat compressed laterally; the longest diameter of the root of the first tooth is two inches; of the second, two and one-fourth; of the third, two inches.

The lateral plates of the dentary bone, come in contact a few inches behind the first tooth.

In another fragment of the jaw, containing five or six teeth, we find the roots placed in actual contact throughout; and knowing the law of their arrangement, we can readily estimate the length of the jaw.

The combined length of all of the fragments collected of the lower jaw, measures four feet, and includes fourteen teeth, which is the full number said to belong to each side in M. giganteus. The series completed would no doubt contain eighteen teeth. As the coronoid and angular processes and the distal extremity are not included in the above measurements, it would be safe to calculate the lower jaw of this specimen to have been six feet and a half long. The cranium measured nearly the same, and would indicate a larger animal than any Mosasaurus yet discovered.

The greater portion of the coronoid element of the left inferior maxilla, is nine inches in length; in the broadest part it measures four and three-fourths inches in width. The border is concave and regularly rounded. This border is quite uniformly two inches thick, while the remaining portion of the fragment is thinner. Another portion of the left lower jaw contains the roots of three teeth placed in contiguity. The crowns or apices of the teeth have been broken away. This fragment is seven inches long, four and one-quarter inches deep, and three and one-quarter thick.

Three large foramina are seen on the external surface, which communicate with the dental canal.

This portion of the jaw is well preserved, and like all the fragments found, is entirely black, and extremely heavy; the high specific gravity as well as the color, is due to their impregnation with iron; the pulp cavities of the teeth, as well as the concentric laminæ of the apices, are incrusted with deposit of exceedingly minute crystals of iron pyrites. In other portions of the bones a deposit of vivianite is occasionally seen.

In the teeth belonging to this species of Mosasaurus, the root is large, the lower extremity inclining backwards; it contains a minute cavity, being nearly solid, and apparently composed of simple osseous tissue. The apex or crown of the tooth arises from a somewhat conical base, which corresponds with the margin of the alveolar cavity; it tapers rapidly to a point; the teeth are recurved and divided into two faces, one looking forwards and outwards, the other presenting backward and inward; the dividing line between the anterior and posterior faces is very distinct, consist-

ing of a sharp unserrated or simple cutting edge. These acute edges or carinæ separate faces, of which the posterior is more convex. The crowns of these teeth were measured by Dr. Fisher, as follows:

	Inches.		*Inches.*
First, anterior face,	1 4-8	posterior,	1 7-8
Second, " "	1 3-8	"	2
Third, " "	1 2-8	"	2 2-8

The pulp cavity extends about as far into the root as the crown, excepting its entrant foramen in the former.

The mode of succession of the teeth is well seen in this specimen, and illustrates the process as indicated by Leidy (Cretac. Rept., p. 51). The fang-like basis of the functional tooth undergoes extensive excavation by absorption to furnish space for its successor, the remaining portion in some places being reduced almost to a shell, yet remaining firmly adherent to the alveolar walls, without the slightest evidence of displacement. This and other specimens examined, prove that the old tooth is not removed till the process of absorption has extended to the alveolar margin, when the crown is easily detached.

The splenial bones present the usual remarkable character. At the posterior extremity of each, the articulating cavity is narrow ovoid in form, subacuminate below, and not so broadly rounded as in the M. dekayi (fig. 47).

	Inches.
Long diameter,	3.25
Transverse,	1.75
Total depth of splenial at extremity,	4.5
Of rounded face below dentary plate,	2.25

The surface appears to be adapted for motion in two directions.

The vertebra which accompanied the jaw measures as follows:

Length centrum,	4.7
Width anterior articular face,	4.55
Depth " " "	4.65

It is a dorsal with diapophyses below the middle; between it and the neural arch, near the articular extremities, the surface is marked with sub-longitudinal rugæ.

This Mosasaur could not have been less than eighty feet in length. *

As compared with M. giganteus, this species presents considerable affinity. The Mæstricht animal was somewhat smaller than either of those here described, the length of the quadrate bone being 6 in. 4 lin., or more as in our specimens of M. dekayi. Its elevated sub-pentagonal lumbars and caudals are also more as in M. dekayi. The non-coalescence of the anterior chevron bones in M. giganteus, may be owing to immaturity. As compared with that of M. maximus, the os quadratum presents several differences and resembles that of M. dekayi. Thus the articular extremity which extends over the ala is small, as in that species; the median posterior ridge is rudimental in the same, not a strong process as in M. maximus, and the knob is small, the posterior decurved process of the proximal articular face nearly in contact with it. The distal longitudinal rib is relatively twice as long in M. giganteus as in M. maximus, and more as in M. dekayi. Other peculiarities are easily found, which may be of little importance. The external part of the distal articular face is pinched up; not at all in M. maximus; the lower part of the ala is much more incurved and the groove on its margin much deeper.

The M. dekayi may attain the dimensions of this species, though none such have come under my observation.

From the lower marl bed of the upper cretaceous, from Monmouth Co., N. Jersey, and Lumberton, Gloucester Co., N. Jersey.

MOSASAURUS PRINCEPS, *Marsh.*

Sillim. Amer. Journ. Sci. Arts, 1869, p. 392.

Prof. Marsh describes an individual of almost equal size to the preceding, which he distinguishes from them by the form of the quadrate bone. He says that the knob near the meatus is well developed; and the proximal articular ex-

* I must express my obligations to Dr. Fisher, for the opportunity of examining the above specimens, as well as for the use of his notes, from which several extracts are made in the above description.

tremity an open sigmoid, characters which might be included in the range of variation of the M. dekayi. The form of the caudal vertebræ is that of M. maximus, and differs from that of M. dekayi. The characters by which the os quadratum differs from that of M. maximus, are, as Prof. Marsh informs me by letter, the great development of the meatal knob, and the slight prominence of the median posterior ridge, which is a strong process in M. maximus. These characters are marked, but their value may not be as yet fully established. The great ala is plane, and with a deep marginal groove.

The number of mandibular teeth (17) distinguish it from M. giganteus. Their crowns are divided into the two usual planes, and are scarcely facetted. They are more than usually curved outwards in the specimen described.

The cups of the vertebræ are nearly round or slightly depressed. Measurements sent by Prof. Marsh are as follows:

	In.	*Lin.*
Median dorsal, length,	4	
Diameter cup, transverse,	3	
" " vertical,	3	4
Median caudal, length,	2	3
Diameter cup, transverse,	3	2.5
" " vertical,	2	10.7

Chevron bones coössified.

Lower marl bed of the upper cretaceous at Hornerstown, Monmouth Co., N. J. Established on a nearly perfect cranium, five feet in length, and numerous vertebræ. Discovered by Jno. G. Miers.

MOSASAURUS DEKAYI, *Bronn.*

Lethæa Geognostica 1838; e Dekay *Mosasaurus* in Annals New York Lyc. III, 135 Tab. *Mosasaurus major*, Dekay, Palæontology New York Geolog. Survey, 1841. *?Mosasaurus carolinensis*, Gibbes, Smithson. Contrib. to Knowl. II, tab. *M. couperi*, Gibbes, l. c. *Mosasaurus mitchillii*, Leidy, Proceed. Acad. Nat. Sci., Phila., 1856; Smithson. Contrib. p. 118, tab. nec *Geosaurus mitchillii*, Dekay Liodon mitchilliihujus operis. *?Baseodon reversus*, Leidy, Cretac. Reptiles, p. 118, Tab. X, 14–15.

This species is most abundantly found in the upper cretaceous green sand of New Jersey. Portions of many individuals have passed under my observation; among them two presented quadrate bones, and several the separated elements of the atlas. The same pieces, of several other species, are fortunately at my disposal, and the preceding cuts present the specific characters to be observed in them, very clearly.

Of a specimen of this species from Holmdel, Monmouth Co., N. J., described by Leidy, there is sufficient material to determine the relative proportions of many parts of the cranium. The muzzle is figured in his Tab. XIX, fig. 6, and shows the distinct elevation of the premaxillary bone. This portion is lost in the M. giganteus. Both the quadrate bones and the teeth are rather smaller than in the M. giganteus of Mæstricht, but numerous isolated teeth occur, which are identical in form with those of the present specimen, which indicate a size fully equal. The neurapophysial pieces of the atlases of the two, when compared, (see Ossemens Fossiles) present marked differences.

A few lumbar vertebræ have been figured by Leidy. In my private collection are shorter or longer series from the columns of four additional individuals. Three are from the long lumbo-sacral region; one consists of eleven vertebræ; their length together is 20 in. 10 lines. A series of five median caudals measures 7 in. 10 lin.

In the Museum of the Academy Natural Sciences, are portions of the vertebral columns of six individuals, but none of them include dorsals, and they differ very much in size. They are all pentagonal rounded at the extremities, more elevated and angular than in M. maximus. The caudals belong to the larger series and have well developed diapophyses and anchylosed chevron bones. The caudals in my private collection are smaller, also pentagonal and with chevron bone *articulated* to slightly elevated bases. The caudal vertebræ on which Morton founded his M. occiden-

talis, is much smaller and with coössified chevron bones; it is without diapophyses and is hence more posterior than any of those of the present species here noted. It belongs to another species, but to which of those here described, if to any, is difficult to determine. Dimensions of anterior caudals of a large ?M. dekayi from the same position as those of M. maximus, measured above:

	Lines.
Length of centrum, (anterior)	32
Width articular face,	34.5
Depth " "	39
Length centrum No. 2, (a little behind)	33
Width articular ball,	38
Depth " "	37

A portion of the left pterygoid bone of the Holmdel specimen above mentioned, exhibits parts and wholes of five alveolæ, and two teeth in place. In the latter the inner face is narrower than the outer, and they are separated in the posterior tooth by a strong angulation. The small proportions of crown to root, as well as other details, are so similar to those of the teeth described by Leidy as characteristic of his *Baseodon reversus*, that I have no hesitation in referring the latter as pterygoid teeth of a large individual of this or another species. The teeth are of equal size, thus differing from those of Liodon mitchillii, and are much smaller in relation to the maxillary teeth than in the same.

	Lines.
Length of whole tooth, pterygoid,	17
Diameter fang, "	8.5
" crown, "	4.5
" " maxillary,	10.5
" fang, "	16.

The pterygoids are in a groove without alveolar septa.

In addition to the characters already pointed out, this species differs from the M. missuriensis as follows, judging from the figures and descriptions of Goldfuss.

In M. dekayi the proötic wraps over the opisthotic to its superior face; in M. missuriensis the exoccipital wraps over to the superior face of the same bone.

In missuriensis the squamosal forms a horizontal three-cornered expansion and only touches the opisthotic behind.

In M. dekayi the squamosal is largely inferior and has no superior expansion.

In M. dekayi the under face of suspensorium is underwrapped by proötic, by the exoccipital in missuriensis. Glenoid cavity two-thirds on squamosal in M. dekayi; not at all on squamosal in M. missuriensis.

Lower (?upper) marl bed of upper cretaceous of New Jersey.

MOSASAURUS FULCIATUS, *Cope*.

Spec. nov.

This species is represented by an os quadratum, three posterior dorsal vertebræ, and an imperfect humerus, obtained by Prof. Geo. H. Cook, from the Green Sand of Monmouth Co., N. J.

The vertebræ are those in which the diapophyses spring from the middle of the centrum, one being quite flattened, and the other triangular in section. The centrum is convex below them; the articular faces nearly round.

The prominent peculiarity is seen in the os quadratum. The ala is broken off. The external angle is considerably smaller than in M. dekayi, though not more so than usual variation would allow. The knob is very prominent, and is separated by a deep groove from an elevated ridge, which extends from the pit and terminates in a rugose prominence representing the process in M. maximus; (see plate xi, f. 7). Anterior to this, another ridge arises from the rugose muscular insertion and extends to the extremity of the bone diverging from the first mentioned ridge, constituting the external distal ridge; the space between these ridges is filled up, and the section across them is that of a prominent rectangular buttress; a wide concavity separates it from the external surface of the ala.

This ridge is the external distal longitudinal of the other species, very much developed. In M. oarthrus it is separated by considerable interval from the median posterior; in M. dekayi it just attains it; here, it extends along the side of and in front of it, to the rugose area in front of the pit. Its prominence produces a produced external posterior angle on the distal articular extremity. The median posterior is much prolonged downwards, and is very rugose; a ridge is also continued from the knob to near the distal articular extremity, and its line is the point of convergence for two series of strong rugæ. The anterior inner ridge is strongly pronounced.

The general size of this species is not more than half that of M. dekayi.

The supposed humerus has a flattened shaft, becoming more cylindric proximally. It looks as though it had been used by Indians as a pestle.

	In.	*Lin.*
Length posterior dorsal,	3	3.3
Depth cup " "	2	3.
Width " " "	2	4.8
Length of os quadratum,	4	8
Width of dorsal rib,		8.5
From knob to external angular quadrate,	2	11.6
Diameter proximal extremity, (average)		11
" transverse, of body at knob,		19.2
" " distal extremity,		11.

MOSASAURUS MISSURIENSIS, *Harlan.*

Ichthyosaurus do., Harlan, Trans. Amer. Philos. Soc., IV, 405, Tab. XX, 1834. *Batrachiosaurus*, Harlan. *Batrachiotherium*, Harlan. *?Mosasaurus neovidii*, Meyer. *?M. maximiliani*, Goldfuss. *M. missuriensis*, Leidy, Cretac. Rept. VII, p. 15, 16, 17, 18.

The centra of the vertebræ of this species are moderately depressed. The centra of the caudals, posterior to the disappearance of the diapophyses, are as wide as deep, and of nearly similar length, and with anchylosed chevron bones. A fine cranium is figured by Goldfuss, and he shows the crowns of the teeth to be subcylindric, incurved and facetted.

An unusually perfect specimen of this species, or one allied to it, was recently exhumed by W. E. Webb, near the town of Topeka in Kansas. My friend, Prof. J. Parker, of Lincoln College, of that place, informs me that it is seventy-five feet in length, and the gentleman who discovered it, that it measures eighty feet. Its mandibular rami are stated by the same person to measure five feet. Measurements of the vertebræ indicate them to be of a size quite similar to those of large individuals which have been discovered in the green sand of New Jersey. They measure as follows, as stated on photographs by my friend, W. E. Webb.

	Inches.
Diameter cervicals centra only,	2.5
" dorsals, with diapophyses,	7
" lumbars,	2

These proportions illustrate again the Ophidian or eel-like form of this genus, and the relatively large size of the head.

The teeth resemble in size those of large specimens of M. dekayi.

The following corrections should be made in the nomenclature adopted by Goldfuss in the explanations of his plate, Nova Acta. Nat. Cur., 1855, Tab. VI to XI.

Tab. VI.

T. is Squamosal, called *temporal.*

T. m. is Opisthotic, " *temporo-mastoid.*

T. p. is Proötic and Epiotic.

P. is a thin lamina of parietal prolonged backwards over supraoccipital.

Tab. XI.

2 ? ? said to be pubis.

3 is Quadratum, " " Olecranon.

From the upper cretaceous of middle North America.

MOSASAURUS OARTHRUS, *Cope.*

Spec. nov.

This species is indicated by fragments of the jaws and teeth, with an imperfect quadrate bone and vertebræ of one individual, and vertebræ and jaws of a second and larger, from the green sand of New Jersey.

The animal as indicated by the above specimens, was of about the size of M. giganteus, perhaps fifty-five feet in length. Its transversely oval centra ally it to the M. depressus and M. missuriensis. The quadrate bone distinguishes it from the former of these, as it more nearly resembles that of the M. dekayi.

The depression of the articular surfaces is not quite so great as in the M. depressus. The diapophyses of the cervicals have much antero-posterior extent, and very little vertical. The hypapophyses are well developed. The surface of the centrum is very coarsely striate or rugose in front of the diapophyses; the posterior portion near the ball is longitudinally striate.

	Lines.
Length centrum, median cervical,	4.3
Diameter cup, transverse,	35.6
" " vertical,	28.6

The superior rim of the cup is excavated openly, by the neural canal. The lateral element of the atlas has the same form and size as in the M. dekayi. The left os quadratum presents several peculiarities, intermediate perhaps between those of M. dekayi and M. depressus. The median posterior ridge and knob are so prominent as to include between them a deep groove which commences at the pit and expands below, ceasing with the extremity of the ridge. The latter terminates rather abruptly, somewhat as in M. maximus, but is not truncate, terminating in an oblique keel. From the knob downwards the bone is longer than in M. dekayi, and the outer distal longitudinal ridge so marked in that species, is either very short or wanting. The inferior extremity of the angle being broken away, its absence cannot be asserted, but it does not appear at a point considerably below its origin in M. dekayi. In the latter species also, the median posterior ridge is very small, and though the extremity is broken off, there is no ridge as a basis for the prominence seen in the present animal. The external angle of the proximal extremity is not as prominent in this species as in M. dekayi.

	In	*Lin.*
Length of quadratum,	6	3
" to knob, (apex)		43.6
" " extremity median post. ridge,		55.5

The development of the median posterior ridge carried a little further, viz: to beyond the pit, to the outer side, throwing it in towards the meatus, constitutes the peculiarity of this element in Mos. depressus.

The crown of the teeth of this specimen were broken away when I obtained them; the false root of one of them measures eighteen lines in diameter. The second and largest specimen, which was found some three years afterwards, was not more fortunate, as the workmen broke off the crowns of its teeth also.

This species was found at the base of the upper green-sand bed of the upper cretaceous of New Jersey, near Barnesboro, Gloucester Co. It was discovered by my friend, I. C. Voorhees, to whom I am indebted for the type specimens.

MOSASAURUS DEPRESSUS, *Cope.*

Geological Survey of New Jersey, App. C.

The remains characteristic of this species consist of cervical, dorsal, and lumbo-sacral vertebræ, and some pieces of the cranium, including os quadratum, from Burlington Co., N. J., in the museum of the Academy, from Lewis T.

Germain: a series of dorsals of a larger animal from the same locality: a series of five consecutive lumbo-sacrals from Birmingham, N. J., in the museum of the Mount Holly Lyceum, and others of the same in my cabinet, from Barnesboro.

The depressed centra and flattened transverse oval of the articular faces of the vertebræ, in the cervical, dorsal, and lumbo-sacral series, distinguishes it at once from the M. maximus, M. dekayi, and the European species. No caudal vertebræ are preserved, so that their form is not known, but it is probably discoid or rounded, as in M. missuriensis. The character is imperfectly seen by comparing the figures on Plate VII of Leidy's Cretaceous Reptiles. Figs. 9 to 14 represent M. dekayi, while 2, 3 and 8 belong to the M. depressus. The vertebræ more nearly resemble those of Platecarpus tympaniticus. The latter differs distinctly as follows: the ball is smaller in proportion to the length of the vertebra, and is less transverse; in one cervical, and one dorsal it has a more oblique uplook; the base of the cervical hypapophyses is carried to the edge of the cup as a narrow keel: in M. depressus as an elevated rounded rib, as wide as the process itself.

The remains preserved indicate an animal of less size than the M. dekayi; perhaps they point to a bulk more like that of the Liodon validus.

	Inches.
Length of centrum anterior dorsal,	3.5
Width cup,	2.3
Depth "	2.
Extent diapophyses,	6.9
Length of five lumbo-sacrals of a smaller individual,	13.5

The lumbo-sacrals resemble in some degree those of M. brumbyi, but differ in important features. In the latter the basis of the diapophysis is carried as a prominent obtuse ridge, to the edge of the ball and rim of the cup, giving the centrum a sublenticular section. In M. depressus these vertebræ have an oval section, as the diapophysis is not continued into the basal ridge, but the cup and ball are well separated from it. Some of the vertebræ figured by Gibbes as typical of M. brumbyi, present an obliquity of the articular faces not characteristic of M. depressus; the feature is slightly marked in specimens from Alabama, in the writer's collection.

Measurements of a lumbo-sacral from Barnesboro:

	In.	*Lin.*
Length centrum,	1	9.5
Transverse diameter cup,	2	
Vertical diameter cup,	1	7.5

No teeth can be certainly ascribed to this species. The quadrate bone is of peculiar form, and distinguishes the species from all others as readily as the vertebræ. The superior or proximal extremity of this bone is characterized by its relative narrowness, and its long continuation on the upper margin of the great ala. The external angle is weaker than in any other species. The ala is strongly convex, not flattened as in the M. maximus; it is less abrubtly given off from the main shaft. The greatest peculiarity of the bone is a massive external longitudinal rib, just in front of the meatus, which throws the pit as it were into the mouth of the meatus, the position of the latter thus differing much from its usual superficial one. The rib sinks to the surrounding level just above the meatus, and is not continued to the external proximal angle as in the Liodon validus, the only known species where such a development of the rib exists.

	Lines.
Thickness at meatus,	16.5
Meatus to anterior end proximal articulation,	25.6
Greatest width proximal articulation,	12.

Two opisthotic bones are described under the head of Liodon validus, which it is just possible shoud be ascribed to the present species. It must be added, that when the caudal vertebræ are discovered they must be compared with that on which Morton founded his M. occidentalis. (See under M. dekayi.)

I have not seen this species from any other region than New Jersey, where it is abundant.

MOSASAURUS BRUMBYI, *Gibbes.*

Amphorosteus brumbyi, Gibbes. Smithsonian Contrib. to Knowledge, II. 9 Tab.; III, 10–16, p. 10.

Vertebræ of this species indicate a reptile of larger size than the M. depressus, and approaching the M. dekayi. The position of the diapophyses is rather more anterior than in others, and the centrum of the lumbars rather more elongate than in any other species of the genus. The articular extremities are slightly oblique to the vertical diameter. The animal appears to be not uncommon in the white cretaceous limestone of Alabama. It was first made known by Dr. Gibbes, in his Memoir on Mosasaurus and its allies, in the Smithsonian Contribution, Vol. II.

	Inches.
Depth cup,	2.05
Width "	2.3
Length centrum,	3.25
Edge ball to base diapophysis,	1.3

Rotten Limestone, upper cretaceous Alabama.

Species of Mosasaurus known only from teeth and cranial bones.

MOSASAURUS CRASSIDENS, *Marsh.*

Silliman's Amer. Journ. Sci. Arts, 1870 (Feb., March).

This species was established on a portion of the maxillary bone with teeth. The latter are peculiar. The crown of one, perhaps representative of all, is short, stout, of nearly circular section at the base and compressed towards the apex. The latter is obtuse, and furnished on each side with a ridge, which together separate nearly equal faces, and do not descend to the base. The apex is slightly rugose; there are no lateral striæ or facets. According to Marsh, the maxillary bone is short and deep, and presents a considerable vertical external face. The remains indicate one of the largest species of the genus.

From the Cretaceous of North Carolina; discovered by Prof. Emmons, formerly State Geologist, Mus. Williams' College, Mass.

MOSASAURUS MINOR, *Gibbes.*

Loc. Cit. 7 Tab. I, 3–5.

This small species appears to have been about as large as the Clidastes iguanavus, Cope.

The Cretaceous of Alabama.

MOSASAURUS COPEANUS, *Marsh.*

Mosasaurus copeanus, Marsh, Proceedings Amer. Asso. Adv. Sci., 1869. Sillim. Amer. Journ. Sci. Arts, 1869, 393.

The remains which at present represent this species are portions of a skull with some of the maxillary teeth, and part of the corresponding lower jaws, including the anterior extremity of the left ramus, and the articular surface of the left splenial bone. They indicate one of the smallest Mosasauroids yet discovered, and one very distinct from any hitherto known. The teeth are slender, compressed, considerably curved, and deeply facetted. They are very pointed, and a sharp ridge, without denticulations, divides the outer from the inner surfaces. The enamel of the crown is remarkably smooth, and quite unlike the usual corrugated dental surfaces of the larger Mosasauroids. The dimensions of a very perfect tooth from near the middle of the left lower jaw are as follows:

	Inches.	*Lines.*
Length of crown and osseous support,	1	11.
Length of crown alone,		10.5
Antero-posterior diameter of crown at base,		5.25
Transverse diameter of crown at base,		4.

The fang-like supports of all the teeth are more firmly coössified with the jaws, than is usually the case in this family, and most of them contain excavations for the successional teeth. On the outer superior edge of the lower jaws there is a row of pits round or oval in outline, and alternating with the teeth. In most instances one is situated outside and a little in front of each tooth, and those in the anterior portions of the jaws are deeper than those farther back. They evidently have been excavated for the maxillary teeth, and are adapted for their reception, like the similar cavities in the jaws of crocodiles. Slight depressions, corresponding to these in position, may be seen in the jaws of some of the larger species of *Mosasaurus*, and the unusual depth of the pits in the present specimen is probably due to the more pointed character of the teeth.

Among the pieces of the skull preserved, is part of a symmetrical bone, about seven inches in length, which formed the superior, medial portion of the face in front of the orbits. Although no sutures are visible, it is evidently composed of the nasal bones, and portions of the attached premaxillary and frontal bones. Its upper surface is very peculiar in form, and is doubtless quite characteristic of the species. It is slightly concave in front where broken off, flat at its narrowest part between the nasal openings, convex as it becomes broader a little farther back, next flat with regular beveled edges at its greatest width between the apertures, and finally very convex as it again expands before coalescing with the medial frontal. This fragment indicates that the nasal bone was very slender, and like the premaxillary undivided, that the superior nasal openings on either side were long and narrow, and that the central line of the face immediately behind them was marked by a low rounded ridge.

From the Lower bed of Cretaceous Green Sand at Marlborough, Monmouth Co., N. J. The size and horizon of this species are quite similar to those of the Clidastes iguanavus.

MOSASAURUS MIERSII, *Marsh.*

Sill. Amer. Jour. Sci. Arts, 1869, 395.

The following description is derived from Marsh, l. c.

This species is indicated by the crown of a single tooth which was found in the lowest marl bed, near Hornerstown, New Jersey. It evidently belonged to a Mosasauroid reptile of moderate size, but appears to differ from the teeth of any yet described, in being more pointed, and in having the sides very deeply facetted or grooved. It resembles strongly the teeth of *Mosasaurus copeanus*, but is more compressed, the enamel of the crown more corrugated, the cutting edges are minutely denticulated, and it evidently belonged to a much larger animal. The crown is an inch and five lines in length, and eight lines in antero-posterior diameter at the base. The facets fade away before reaching the apex, which is nearly smooth.

This tooth is apparently too large for either of the species of *Baptosaurus* described below, the remains of which were found in the same immediate vicinity, but it may possibly belong to *Liodon lævis*, the teeth of which are unknown.

PLATECARPUS, *Cope.*

Proc. Bost. Soc. Nat. Hist., 1869, 264.

This genus is especially characterized by the peculiar insertion of the pterygoid teeth. Its humerus also is more chelonian than that of Mosasaurus, while the os quadratum presents marked differences. These peculiarities have been pointed out by Leidy, who refers the species to the genus Holcodus of Gibbes. Now this genus, Leidy also shows, was made to include, also, teeth of Hyposaurus, but the name, as its meaning is "grooved tooth," should be restricted to that Mosasauroid genus, to which it is applicable.

For, as it has been accepted for the Mosasauroid included by Gibbes, by the next writer, Leidy, it must be retained for it, according to the just rule usually followed. There is, however, for us no evidence that the present genus possessed such a tooth, and as the teeth of all the genera bear such a close mutual resemblance, I think it must be left for future discovery to determine the application of the genus Holcodus. Name from Πλατη an oar.

Dorsals transversely ovate, rounded; quadrate bone broad as long, meatus larger; humerus little contracted medially, with flat shaft; pterygoid teeth, eight.

P. TYMPANITICUS.

PLATECARPUS TYMPANITICUS, *Cope.*

Holcodus acutidens, Leidy, Cretaceous Rept. N. Amer., p. 118, Tab. VII 4–7; VIII 1–2–7; XI 14; vix Gibbsii Smithson. Contrib. 1851, II 7, Tab. I, 3–5, vel Leidyi, Loc. Cit. Tab. X–17.

This species is of about the size of Mosasaurus depressus, Cope, under which head some of its characters are pointed out. The single specimen representing it, was found in the upper cretaceous of Mississippi, near Columbus, by Dr. William Spillman.

LIODON, *Owen.*

Report on British Fossil Reptiles. Proceedings Brit. Assoc. Adv. Sci., 1841, p. 144. Odontography p. 261, Tab. LXXII, fig. 1–2. ?*Macrosaurus*, Owen, Journ. Geolog. Soc. London, 1849, 380. Cope, Proc. Bost. Soc. Nat. Hist., 1869, 264. ?Nectoportheus, Cope, Proc. Acad. Nat. Sci., 1868, 181.

This genus was defined by Owen, in consequence of the more compressed and less facetted character of the teeth in the type species, L. anceps, Ow. of England. This character, though important, is shown by Leidy to be evanescent, as indicated by more than one species of the United States. I find these species to differ materially from Mosasaurus in the separation and linear form of the pterygoids. The characters are chiefly derived from the L. proriger, Cope, and L. mitchillii, Dekay, as follows:

The pterygoid bones without contact on the median line, but separated by a considerable interspace throughout their length. Pterygoid not entirely pleurodont. Chevron bones free to the end of the vertebral column; dorsals with rudiment of the zygosphenal articulation.

These characters may be those of *Macrosaurus*, Owen, but the palatal characters of the type of that genus are unknown; they are probably similar to those here given, as it approaches Clidastes in the form of the vertebral arches, and the pterygoids are separate in the latter. The vertebræ known to belong to L. proriger present the compressed form of those of Liodon lævis. The vertebræ of L. mitchillii are, however, unknown. The pterygoid tooth of a species like the last was named *Lesticodus* by Leidy. I have not used this name for the present genus, as the species and genus to which the type pertained are not

readily identified, and its author has given the name the position of a synonyme. Owens' Liodon presents teeth similar to those of M. impar, but here again we do not know any other characters of the genus.

The characters are well distinguished from those of Clidastes on the one hand, and Mosasaurus on the other. The vertebræ are those of the latter genus, while the pterygoids do not present that union on the median line characteristic of the same. They have not the horizontal expansion seen in Clidastes. Their teeth are not arranged after a type so strongly pleurodont as in Platecarpus, but in the type species they are more exposed than in Mosasaurus giganteus, M. missuriensis and M. dekayi. As Leidy describes the pterygoid bone of Platecarpus tympaniticus, I am induced to suppose that they are united on the median line; the width above is nearly one-third the length, and a shelf "projects on the inner side separating the upper from the lower surface." This is as in Mosasaurus, and constitutes probably, a point of union of the two bones.

This separation of the Pterygoids is characteristic of Lacertilia and Ophidia generally, while the continuous relation belongs rather to Crocodilia, Sauropterygia, etc.

The entire distinctness of the chevron bones of the caudal vertebræ is remarkable, as differing from the known structure of M. giganteus, M. missuriensis, M. dekayi, and Clidastes propython. The large size of the L. proriger renders it improbable that this feature is to be ascribed to immaturity, especially as the two species last named as differing in that respect, are relatively quite small. A species from the rotten limestone of Alabama, presents a similar characteristic of the caudal vertebræ, but whether its pterygoids be those of Liodon or Mosasaurus, I am unable to ascertain.

Pterygoids nine, smaller, cylindric; mandibulars eleven, much larger; anterior teeth convex inwardly, indistinctly fluted; premaxilla with two teeth on each side, prolonged into a cylindric rostrum. L. PRORIGER.

Pterygoids eight, unequal, the median large, almost equal to the mandibulars; teeth compressed, with two edges, inner sides little convex; no flutes or marked facets. L. MITCHILLII.

The only character by which I distinguish the L. validus from Mosasaurus, is the peculiar form of the os quadratum. The L. lævis is characterized by the form of its vertebræ, which differs considerably from that of any species of Mosasaurus. They may be compared as follows:

Cervical cups vertically oval, proximal caudal subhexagonal; surfaces striate; size large. L. PRORIGER.

Articular faces cervicals and anterior dorsals round; posterior dorsal depressed, centra short, broad; large. L. VALIDUS.

Articular faces posterior cervical round or slightly depressed; hypapophysis very large; surface everywhere sculptured striate; centrum long; small. L. CONGROPS.

Articular faces of all dorsals compressed, deeper than wide; median line below, broadly prominent. L. LÆVIS.

LIODON PRORIGER, *Cope.*

Macrosaurus proriger, Cope, Proceed. Ac. Nat. Sci., Phil., 1869, p. 123. Hujus operis Tab. XII, figs. 22–24. Leidy, Cretac. Rept. II, 15–16 (caudal vertebra).

The history of this large Mosasauroid is based on material in the Museum Comparative Zoology, Cambridge, Mass., brought by Prof. Louis Agassiz from the cretaceous beds in the neighborhood of Fort Hayes, Kansas, and near the line of the Southern Pacific Railroad. It consists of the greater part of the muzzle from the orbits, with the right dentary and left pterygoid bones nearly complete; one cervical vertebra (with hypapophysis), one dorsal, one caudal with diapophysis, and ten caudals without diapophysis.

The characters presented by the vertebral column indicate an excessively elongate reptile; the transverse diameter of one of the distal caudal vertebræ is less than one-fifth that of a proximal with short diapophysis; while four consecutive ones of the former show but little variation in dimensions. This diminution amounts to $\frac{2}{7}$ of a transverse diameter of the larger form. With this ratio as a basis, fifty-three $\frac{2}{3}$ vertebræ would form a complete series from caudals one-half the diameter of the last of the four, to the proximal caudal above mentioned. There have been, no doubt, several caudals in advance of the latter, as the diapophyses are small. From the slow rate of diminution of the columns of other species examined, it may be supposed that sixty caudal vertebræ is below rather than above the true number.

The cervical and dorsal vertebræ have been slightly crushed as they laid on the side, and present a narrower diameter than is normal; the cup of the cervical has not been distorted, and is deeper than wide, presenting the character of Macrosaurus. The rudimental zygosphen consists of a continuation of the roof of the neural canal in front, to adapt itself to the inner face of the down-looking zygapophysis of the preceding vertebra. The latter is thus received into a groove on the inner side of the up-looking posterior zygapophysis. The dorsals and caudals exhibit with the cervicals that minute, sharply defined rugosity, which characterizes all the projecting margins, especially those of the hypapophysis and diapophyses, in this genus and Clidastes. The whole surface of the cervical is marked with either inosculating striæ or impressed punctae. The same character marks the cranial bones, though they do not present such rugosity as the vertebræ.

The proximal caudal presents a subhexagonal section, of which the inferior add supero-lateral sides are longest; articular faces about as broad as high. A broad smooth space between the chevron bones. Diapophyses with broad ovate transverse section.

A caudal without diapophyses, anterior to the middle of the series, estimated by the size, is but slightly deeper than long, and with parallel lateral outlines of the articular faces. The neural arch is very much narrowed antero-posteriorly, but has a greater transverse extent at its lower part; above the spine is much compressed, but not widened. The zygapophyses remain as rudiments just above the small neural canal, but do not probably touch each other. There are two anterior and two posterior narrow ribs on the upper portion of the neural spine. The more distal caudals have wider neural spines, and the arch also has a greater antero-posterior extent. The zygapophyses are scarcely traceable and the neural spine is strongly striate. The reverse arrangement is observed in Clidastes propython, where the neural spine of the proximal caudal has considerable extent, while those of the posterior and distal vertebræ are almost cylindric, especially the neurapophyses.

Dimensions.	*In.*
Dorsal, length,	3.35
" width cup,	2.5
" depth "	2.77
Proximal caudal, length,	2.14

	In.
Proximal width cup,	3.43
" depth "	3.23
Caudal without diap. No. 1, length,	1.6
" " " " depth cup,	2.65
" " " " width "	2.6
" " " " height neural canal,	.4
" " " " antero-posterior width neural spine,	.8
Caudal do., No. 2, length,	1.2
" " " depth cup,	2.15
" " " width "	1.86
" " " " neural sp. (antero-posterior),	1.07
Caudal do., distal; length,	.5
" " " depth cup,	.85
" " " width "	.64
Caudal do., distal; diameter antero-posterior, of neural spine,	.40

The points of attachment of the chevron bones on the distal vertebræ are strongly marked pits; on the anterior, the anterior margins of the pits are raised and continuous with the chevrons.

The muzzle presents the usual characters of the large Mosasauroids, but adds a peculiarity in the prolongation of the premaxillary bone into a cylindric mass forming an obtuse beak beyond the premaxillary teeth. The bone is narrowed anteriorly, and does not descend regularly as in Mosasaurus sp., but continues to its abrupt and narrowed termination described. The extremity is deeper than wide. Immediately in front of and between the anterior premaxillary teeth, a short acuminate projection interrupts the surface, and in front of this, a transverse depression. Above, the surface becomes flattened, and presents two shallow longitudinal depressions continuous with the nostrils. Where the premaxillary rather suddenly contracts into its spine, it is materially wider than the maxillary on each side of it; in M. missuriensis it is narrower, according to Goldfuss. The maxillary border of the nares is rather suddenly concave at the anterior extremity of the nares, narrowing the maxillaries; the latter gradually widen by the expansion of their inner margins.

No part of the frontals is preserved, but a considerable part of the left pre-frontal remains. It unites by a very coarse overlapping suture with the maxillary, whose outline forms an irregular chevron with the apex pointing forwards in the middle of the maxillary bone. This, it will be seen, is very different from the form given by Goldfuss in the M. missuriensis, where the most anterior point of the suture is on the nareal margin. The external margin of the bone behind is contracted considerably within the maxillary border, previous to its outward extension towards the orbit. This is much less marked in the Clidastes propython, but is distinct in M. missuriensis.

The maxillo-premaxillary suture gradually descends to the alveolar border to the extremity of the maxillary bone, where it descends abruptly, forming an interlocking suture quite different from that squamosal type already observed in other species of the order. The length of the premaxillary anterior to this point, is three-fourths the length of the same to the beginning of the nares.

The number o teeth on the maxillary bone was probably thirteen; twelve alveolæ and bases remain, and one is added in the position of the posterior tooth of M. missuriensis, if such existed; this may be questioned in consideration of the small number of mandibular teeth. Premaxillary teeth two on each side, the anterior with bases separated only by a groove. Throughout the whole series the bases of the teeth are considerably more exposed on the inner than the outer side.

The crowns are everywhere sub-cylindric at the base, the inner face more convex than the outer. Posteriorly there is a posterior cutting ridge, as well as a marked anterior one, both minutely crenulate, but the former disappears till in the anterior teeth there is only an anterior edge, the posterior face being convex and continuous with the inner. There is a trace of cutting edge on the outer portion of the extremity of the crown in the most anterior teeth. The anterior ridge remains very strongly marked. The surface is quite rough with longitudinal ribs, of which eight may be counted

on the outer aspect of the second maxillary. These are not strongly marked, and are separated by concave facets. The basal part of the crown is marked by numerous fine sharp striæ, which are most distinct on the inner face.

The external face of the maxillary bone presents three series of foramina. These rise superiorly on the premaxillary, and increase in number and become irregular on its extremity.

The ramus of the mandible is massive, and differs from that of Mosasaurus giganteus in continuing its proportions to its extremity. Its depth at the latter point is as great as the sixth tooth from the front. It is prolonged beyond the first tooth in correspondence with the prolongation of the premaxillary. This extremity is compressed and obtuse; its inner face is very rugose, as though there had been a closer union at the symphysis than usual, though it would not appear to have been other than ligamentous. The groove for Meckel's cartilage is very large and has been exposed below the last two teeth, as the splenial terminates at the third. Two series of foramina on the external face of the ramus. There are alveolæ and bases for thirteen teeth on the dentary bone. This, it will be observed, is one more than in M. gracilis, and one less than in other species of Mosasaurus. The posterior extremity of the dentary shows its marks of reception into the notch of the coronoid; it is more compressed and less club-shaped than the corresponding part of M. mitchillii, and would indicate less lateral flexibility than in some other types.

The right pterygoid is of less elongate form than in some other species. It presents the sutural face for union with the palatine on the outer anterior extremity, and narrows to an apex a little in advance. The dentigerous face is widest at the anterior third the length, where the outer margin is expanded. This then contracts and is compressed vertical at the tenth tooth, where it is broken off. The transverse process is given off a little anterior to the ninth tooth. The interior face of the bone is a vertical plane, without projection, except a slight obliquity at the anterior extremity, and it is clear there has been some interval between this pterygoid and its fellow. The superior margin is obtusely rounded.

The bases of the pterygoid teeth are exposed for two-thirds their length, on the outer side of the bone, thus approaching the Platecarpus. The antero-median are large, and the anterior most closely placed. Their crowns are strongly recurved, round in section, and with a fine sculpture of straight striæ, most marked near the base and on the inner side. They are more spaced posteriorly than any other species except M. mitchillii, and are relatively larger than in any except the same species. They have not the compressed form with basal shoulder, characteristic of the M. dekayi.

Measurement of Muzzle.	*Inches.*
Length of fragment,	31.
" from end muzzle to pre-frontal,	21.5
" " " " " nares,	11.75
" " " " " maxillary,	5.75
" " " " " first tooth,	2.5
Width of muzzle at end,	1.5
" " at anter. extremity nares,	8
" premaxillary " " "	3.3
" maxillary betw. 10th and 11th teeth,	3.2
Depth mandible at extremity,	2.5
" " " sixth tooth,	3.5
" pterygoid at transverse process,	2.5
Width " " " "	1.4
" " in front,	2.2
Length " anterior to transverse process,	7.2
" crown 5th pterygoid tooth,	1.
" " 2nd maxillary tooth,	1.9
Diameter " " " " at base,	1.1

The vomers are as usual, separate and narrow. They are in close contact from the second maxillary to the second premaxillary tooth. Throughout this part of their length they are embraced by posteriorly produced vertical laminæ

of the premaxillary bone. These laminæ unite just behind the second premaxillary teeth, and form a single prominent keel, which disappears between the first premaxillaries.

This very fine fragment of one of our largest extinct reptiles, was enclosed in a matrix of soft yellow chalk. It was lent me for introduction into the present synopsis by Prof. Agassiz, of Cambridge, Mass. We look with interest to a complete restoration of this species, as its matrix is so readily worked.

LIODON MITCHILLII, *Dekay.*

Geosaurus mitchillii, Dekay, Annals Lyc., New York, III, 140. Bronn, Lethaea Geognostica: nec *Mosasaurus mitchillii*, Leidy, Cretaceous Reptiles U. S., et Cope olim, Boston Proceedings, 1869,=M. major Dekay.

Drepanodon impar, Leidy, Proceed. Acad. Nat. Sci., Phila., 1856, 255. *Lesticodus impar*, Leidy, Geolog. Surv. N. Ca., 224, figs. 45-6;—fide Leidy. *Mosasaurus*, Leidy, Cretaceous Reptiles, 65—Tab. XI, 1, 2, 3, 4.

This species is well characterized by the unequal size of its pterygoid teeth, and by the near equality of some of them to the mandibular. Leidy observes that the fang of the first tooth indicates that it was smaller than the second; the second, third and fourth are nearly equal, and large, then the first and fifth of equal and smaller size, and the sixth to the eighth successively smaller. The teeth from the second to the fourth are nearly equal in size to the mandibulars, and with only one divisional cutting edge. The mandibulars present two, nearly opposite, and faint traces of facets only.

The case is entirely different with the M. dekayi, where, as indicated by the measurements, the pterygoids are sub-equal and very much smaller than the mandibulars.

Other portions of this species are unknown, hence it may be found at some future time to be the same as some other here described. In that case, the name mitchillii will take precedence over any subsequently given.

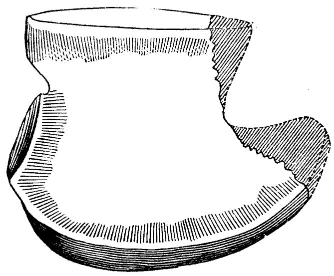
From the lower marl bed, Monmouth Co., New Jersey. Prof. Geo. H. Cook.

LIODON LÆVIS, *Owen.*

Macrosaurus lævis, Owen, Quart. Journ. Geol. Soc. Lond., 1849, 380 tab. Leidy, l. c. 74, 75; (per errorem *Macrosaurus validus* Tab. V hujus operis.)

Portions of three individuals referable to this species have come under my notice, viz: two vertebræ and a radius from Monmouth Co., N. J., found by Dr. Samuel Lockwood; three vertebræ from the same county, from O. R. Willis, and a single vertebra from Medford, Burlington Co., from Charles Braddock. The largest individual of the three is that from Dr. Lockwood's collection, which is nearly equal to the largest of the M. validus, but considerably less than that of the M. proriger. The cervical has the round articular faces, while the dorsals present the vertically ovate form of cup and ball characteristic of the species. They present also the fine striation of the margins of the diapophyses and of other articular faces. The radius has the outer margin broken away, as represented in the accompanying wood cut; its humeral articular face is narrow ovate; the carpal curved and stout. The bone is very peculiar, in the presence of a short sub-cylindric process directed inwardly to the ulna, and apparently adapted to it by a concave articular face. The radius of Clidastes and that of Mosasaurus figured by Leidy (VIII, f. 10, Cretac. Rept.) merely approach or touch the ulna by the distal angle.

Fig. 49.



Measurements of Supposed Radius.

	In.
Length,	2.73
Distal width preserved (straight line),	3.10
Proximal " "	1.9
Width ulnar articular face,	1.0

A small portion of the external margin preserved, shows a deep incurvature of the outline.

The other specimens from Monmouth Co. are considerably injured. The centrum of the first dorsal, or that with the last trace of the hypapophysis, measures 3.10 inches in length, and the cup 2 inches in diameter. The surface on each side of the trace of hypapophysis is strongly longitudinally striate.

The third specimen is more posterior in position than any of the other vertebræ described, and more compressed in certain parts of the surface.

It is an anterior dorsal, being without hypapophysis, having strong diapophyses, and strong neurapophyses which I suspect to have borne zygapophyses, though these have been broken off. It differs from those of Mosasaurus, which occupy the same position, in its greatly compressed elevated form, in the strength of the neurapophyses, in the longitudinal instead of vertical diapophyses, and in the lack of connection by elevation or otherwise between the diapophysis and base of neurapophysis.

The form of the articular ball is a vertical oval with sub-parallel sides, and a deep rounded emargination at the neural canal. The centrum is much contracted immediately in advance of this, and the outlines above the diapophyses are markedly concave. The neurapophysis rises at about one-fourth the length of the centrum in advance of the ball. The diapophyses have ovate bases deeper anteriorly, and are situate at the middle of the depth of the centrum on the anterior half. The cup is strongly cordate, having an open concavity at the neural canal; the edges are thin. The inferior surface presents a narrow plane, concave extero-posteriorly, and bounded by the compressed sides, which form a longitudinal concavity below the diapophyses.

	In.	*Lin.*
Length of vertebra below,	2	1
Width in median plane below,		7.5
Depth of cup, greatest,	1	9
" " least,	1	7.5
" ball,	1	7.5
Width "	1	5.7
Length basis diapophysis,		13.

This specimen was found near Medford, N. J., in the second green sand bed, and presented to the writer by Charles Braddock, of Haddonfield.

The last described vertebra is erroneously named *M. validus* on Plate V.

LIODON CONGROPS, *Cope*.

Spec. nov.

This species is indicated by a posterior cervical vertebra, which presents so many characters as to render its exclusion from the present work scarcely proper. In size it bears some relation to the *Mosasaurus minor*, Gibbes, but is still smaller, and is separated at once by the round instead of depressed articular faces.

The posterior articular face is the round one; the anterior is slightly depressed, and opposite the diapophyses and neural canal slightly flattened, so as to give a slightly tri-lateral superior outline to the cup. It is not excavated above, as in the species of Clidastes. The hypapophysis is broken, but its base is unusually long and wide. The infero-anterior limb of the short diapophysis descends to the edge of the cup, considerably below its middle. The space it encloses with its superior ridge which extends into the anterior zygapophysis, is reticulate striate. The whole surface below is minutely striate; the striæ become coarse as it approaches the ball. The latter is surrounded by a groove, and its margin projects acutely beyond the adjacent surface of the centrum. The latter is much contracted behind the ball, and the faces below the diapophyses are concave. Bases of neurapophysis striate. Neural arch broken away above. Neural canal with epapophysial ridge.

	Lines.
Length centrum with ball,	20.8
" " to "	18
" " " hypapophysis,	5.8
Width base hypapophysis,	5.5

	Lines.
Depth ball,	10.4
Width "	11
" cup,	12.6
Depth "	11.
Length base neurapophysis,	12.

In profile the base has a very slight obliquity looking upwards.

From the Rotten Limestome of Alabama; discovered by E. R. Showalter, M. D.

LIODON VALIDUS, *Cope.*

Macrosaurus validus, Cope, Proc. Boston, 1869. *Nectoportheus validus,* Cope, Proc. A. N. Sci., Phil. 1868, p. 181. Leidy, Cretac. Rept. 74–75; Tab. VII, 19, 20, III 1–2.

This species is represented by two cervical and four dorsal vertebræ of one individual, and a large dorsal of another, in the Museum of the Academy; the former associated with numerous fragments, including part of an os quadratum, from L. T. Germain, Burlington Co., N. J. Two dorsal vertebræ of a large individual in the Museum of Rutger's College, submitted to me by Prof. Cook; several vertebræ with broken quadrate and other bones and teeth, in my private collection, from near Barnesboro, Gloucester Co., N. J.; a similar series with portions of the cranium from the same locality, in Cabinet of N. J. State Geol. Survey, and a number of vertebræ in the collection of Prof. Marsh, of Yale College, further establish its characters.

The *quadrate bone* is highly peculiar, as above pointed out. The posterior descending hook of the proximal extremity is quite short, and is marked by an obtuse ridge which passes forwards and disappears immediately above the pit alongside the meatus. What especially characterizes this species and genus, and allies it to Clidastes, is the presence of a strong longitudinal angular ridge, which extends from the usual external angle of the proximal extremity, which becomes here a process, separating the outer aspect of the quadratum into two entirely distinct planes; one that of the meatus, the other that of the ala.

Two separate *opisthotic bones* accompany these remains, which were mixed up with those of the M. depressus. The vertebræ of the two species were easily separated. The quadrate bone also was identified by one accompanying the vertebræ of M. validus in my own collection. I could not so readily assign the opisthotics to the proper species. I have assigned them here, because their glenoid cavities apply much more readily to the quadrate bone of the M. validus than of the M. depressus. As compared with the same bones of three Mosasaurus dekayi, they present three marked characteristics. First, they are relatively much shorter; second, the distal anterior process which fits within the squamosal, is much more prolonged; third, the inferior of the two faces to which the squamosal is applied, is a continuation of the general inferior plane of the bone; in M. mitchillii it is a different plane, like a rabbet. It may be added, that the glenoid cavity is narrower and deeper.

Four teeth from Barnesboro, indicate marked characters. They are much compressed, as in L. mitchillii, and the posterior cutting edge is well developed and forms the narrowed extremity of an elliptic section. The anterior ridge less developed. In three crowns there is no trace of the unequal division by these edges, as in Mosasaurus sp. One probably from the premaxilla is more abruptly recurved than in the others, with base rather expanded inwards. The distinguishing character of these teeth, which separates it from L. mitchillii, is the abundant longitudinal fluting and striation of the enamel. The grooves are deeper and shallower, coarser at the base; the striæ are fine, contiuuous and rugose. These are not seen in L. mitchillii. The general form of the crown is short, broad at the base and well curved posteriorly and inwards.

	Lines.
Elevation of crown and pedestal,	21
" " alone,	16
Antero-posterior diameter do. at base,	12

The lateral element of the *atlas* is represented from the inner side in Fig. 48, No. 3. The anterior termination of the inferior ala, and the articular face for the centrum, are as in M. mitchillii. The inner articular face is divided

by a vertical depression; the posterior, or that meeting the odontoid process, is quite prominent and distinct. The anterior facet for the occipital condyle, is transversely divided by a depression.

The form of the *cervical vertebræ* is so much like that of the Mosasaurus dekayi as to be readily taken for those of small example of that species. The first dorsals, or those without hypapophysis, are more elongate than in the latter, and the body is more cotracted, so that the ball presents a projecting rim all round. This is readily knocked off in the rough handling the specimens usually receive. The cup is also proportionately expanded. *Posterior dorsals* where the diapophyses issue half from the centrum, have the latter slightly depressed; where the diapophysis comes three-fourths from the body, the articular faces are a broad transverse ovate, well expanded on the margins, below which the surface is slightly striate. In the longer or anterior dorsals, the rudiment of zygosphen and zygantrum is well marked.

Unfortunately, no caudal vertebræ of this species have been preserved, so that I do not know their form. The posterior dorsals are so much more depressed than in Liodon lævis, that future discovery may justify the generic separation of the genus Nectoportheus, which I originally applied to this animal.

For the largest measurements, I refer to Dr. Leidy's essay on Cretaceous Reptiles, where the description of the large specimens of Macrosaurus lævis belong to the present species.

The following are the proportions of the smaller and typical individual, from L. T. Germain:

	Inches.	*Lines.*
Length centrum cervical, (with ball)		34
Depth ball of same,		18.5
Width " "		21
Length anterior dorsal,		34
Width cup,		24
Proximal width outer face quadratum,		28
Length quadratum to lower edge pit,		20
" opisthotic, (see description)	3	4
" outer margin do.,	3	4

This was a large and powerful reptile, and probably more elongate in proportion to its bulk than the Mosasauri, well deserving the name *Macrosaurus* which Owen has applied to an ally.

From the upper Green Sand Bed of the New Jersey Cretaceous.

BAPTOSAURUS, *Marsh.*

Proceed. Acad. Nat. Sci., Phila., January, 1870. *Halisaurus*, Marsh, Sill. Am. Jour. Sci. Arts, 1869, 395, nec Johnsonii, 1866.

A genus known chiefly from vertebræ. These resemble those of Liodon, more particularly such species as L. validus, but present marked differences in the cervical part of the series. Here the hypapophyses are compressed and elongate, and rugose at the extremity for the insertion of muscles, instead of being truncated by an articular face to which a separate bone is united, as occurs in all the other genera of Pythonomorpha here enumerated. In this it more nearly resembles the ordinary types of Lacertilia and Ophidia. There is no indication of zygosphen in the two species described. The neural spine is elevated, compressed, and narrow. The dorsals are of an even more elongate character than in Liodon. The species known have the articular faces depressed or transverse oval. This character is not necessarily of generic value, and hence I attach less importance to it than does Marsh in his diagnosis.

The species are as follows:

a Articular extremities of dorsal vertebræ depressed.

Cervicals much depressed and with smaller articular faces than dorsals; inferior aspect of cervical centra keeled medially and laterally. B. PLATYSPONDYLUS.

Dorsals with transversely oval cups, less depressed and less elongate. B. FRATERNUS.

BAPTOSAURUS PLATYSPONDYLUS, *Marsh.*

Macrosaurus platyspondylus, Marsh. Proceed. Amer. Assoc. Adv. Science (Salem), 1869. *Halisaurus platyspondylus*, Marsh, Silliman's Journ. Sci. Arts, 1869, p. 395.

This most distinct species was established on a median cervical, and an anterior dorsal vertebra; the right splenial bone with its concave articular face, and a small portion of the base of the skull. A coracoid found near these specimens probably belonged to the same animal, although it is smaller than the other parts of the skeleton would apparently indicate, and differs considerably in form and proportions from the corresponding bone in both *Liodon* and *Clidastes*. The splenial bone differs from that of *Mosasaurus* in the form of its articular face, and in being more overlapped in front of the joint of the dentary.

Through the kindness of Prof. Marsh, I have had the opportunity of making the present observations. Other parts of the description are copied from his description quoted above.

The cervicals present smaller cup and ball in proportion to those of the lumbars, than is seen in any other known Mosasauroid; they are so depressed as to be nearly twice as broad as deep. The inferior, horizontal limb of the diapophysis is prominent below, leaving on each side of an obtuse median keel, a lateral shallow concavity. The median keel scarcely projects beyond the lateral. The neural arch is slightly more contracted above antero-posteriorly, than in any other species, hence the zygapophyses are more prominent. The neural spine is contracted antero-posteriorly and much elevated. The hypapophysis is on the posterior portion of the inferior surface, and is quite prominent, but shorter than the centrum. The posterior dorsals resemble only those of Liodon validus out of the genus; they are considerably more slender, and without the obtusely keeled form of the inferior face, characteristic of the latter.

The dimensions of the posterior cervical vertebra are as follows:

	Inches.	*Lines.*
Length of centrum below,	2	6
Transverse diameter of articular cup,	1	8.5
Vertical diameter of articular cup,		11.
Distance from centre of cup to middle of lateral edge,		11.
Length of diapophyses below lower margin of cup,		5.5
" " hypapophysis below lower margin of ball,		8.

The dorsal vertebra has no trace of hypapophysis, and the lower surface of the centrum is remarkably flat. The anterior downward prolongations of the diapophyses still project below the centrum, but they have become obtuse processes, partially separated from the more vertical portion of the diapophyses by a notch. The following are the more important dimensions of this vertebra:

	Inches.	*Lines.*
Length of centrum below,	2	6.
Transverse diameter of cup,	1	9.
Vertical " "	1	
Width of neural canal below,		6.
" between extremities of anterior zygapophyses,	2	3.
Length of diapophyses below lower surface of centrum,		2.

If the coracoid found near them belongs to the same skeleton, the body was remarkably slender, and the fore-limbs possessed comparatively little power.

From the clays below the upper bed of Cretaceous Green Sand at Hornerstown, Monmouth Co., N. J. Discovered by Jno. G. Miers.

BAPTOSAURUS FRATERNUS, *Marsh.*

Halisaurus fraternus, Marsh, Amer. Jour. Sci. Arts, 1869, 397.

This species is established on an anterior dorsal and two posterior dorsal vertebræ, found not far from each other, and probably part of the same series. They are about the same size as those just described, and have many points of resemblance to them, but differ in having the centra less depressed and less elongate. The anterior dorsal has the zygapophyses less expanded, and their articular face more nearly vertical than the corresponding parts in the previous species. It has also indications of a small hypapophysis, which in form and position resembles somewhat that of *Mosasaurus.* The neural spine is compressed, of moderate height, and directed slightly forwards. The posterior dorsals have the centra considerably less depressed than the anterior dorsals, and the neural arch rests upon the anterior two-thirds of the centrum. The diapopophyses pass off horizontally, their upper flat surface being nearly in the same plane as the floor of the neural canal. At their extremities there is an articular face which is subtriangular. These vertebræ are all much more depressed than those of *Liodon lævis,* Owen, or *L. validus,* Cope, and indicate an animal smaller than either of those species, probably twenty-five or thirty feet in length. The remains were found near Hornerstown, New Jersey, by Mr. Meirs, at the same locality as those described above.

The preceding description is quoted from Marsh, loc. cit. A vertebra probably of this species is in the Museum of the Academy Natural Sciences.

HOLCODUS, *Gibbes.*
HOLCODUS ACUTIDENS, *Gibbes.*

On Mosasaurus, Smithsonian Contributions, 1851 9: Tab. Leidy, Cretaceous Reptiles, p. 118, Tab. X, fig. 17.

Cretaceous formation of Alabama and Mississippi.

POLYGONODON, *Leidy.*

Proceed. Acad. Nat. Sci., Phila., 1856. 221.

This genus is only known from teeth. These are of remarkable and elegant form, and could scarcely have pertained to animals which presented any close affinity to Mosasaurus. Their cutting edges are equally developed and acute on both anterior and posterior aspects, and separate equal faces. The facets are better defined than in any other genus. There are two species, as follows:

Facets six inner and seven outer. P. VETUS.

Facets four or five inner and outer. P. RECTUS.

POLYGONODON VETUS. *Leidy.*

Loc. Cit., 1856, 221; Cretaceous Reptiles, tab. IX., 12–13.

Cretaceous Green Sand of New Jersey.

POLYGONODON RECTUS. *Emmons.*

Mosasaurus rectus, Emmons, Geological Survey, N. Ca., 1858, 218. *Polygonodon rectus,* Emmons, l. c. tab.

Emmons found his specimen in the miocene in North Carolina, but considered it an intrusive fossil from the Cretaceous. The present survey under Prof. Kerr has a similar specimen also from the Miocene.

Miocene of Bladen and Duplin Counties, North Carolina.

CLIDASTIDÆ.

CLIDASTES, *Cope.*

Proceedings Academy Nat. Sci., Phil., 1868, p. 233.

This genus was originally established on a species represented by a single dorsal vertebra, but its characters have been chiefly developed from remains of two other species, especially the nearly complete skeleton of the C. propython. The vertebra is highly characteristic, and resembles considerably that of such genera of Iguanidæ as Euphryne and Dipsosaurus, and in some degree those of Cyclura and Iguana. It differs from the dorsals of known serpents in having the zygosphen on the plane of the anterior zygapophysis, and in having the costal articular surface continuous with and covering the diapophyses. It differs from the genera of Iguanidæ mentioned, in the very small amount of upward direction which the face of the articular ball of the centrum exhibits.

The zygapophyses are spread apart, and their outer margin continues in a straight line from the diapophyses. The diapophyses are directed upwards, and are vertical compressed in form; they are opposite to about equal portions of the centrum and neural arch. Their posterior face is slightly concave, and the upper face behind forms, with the neural arch, a deeply concave line. The convexity of the ball is not so great as in the Crocodilia, and with the thin-lipped cup, resembles that of Mosasaurus; this resemblance is heightened by the slightly depressed upper outline of the ball, and the form of the diapophyses.

The genus is most nearly allied to Liodon, in some of the vertebræ of which a slight groove beside the zygapophysis is the rudiment of the zygantrum.

The *premaxillary* is a narrow, simple element, one-half of a cone anteriorly, and much attenuated posteriorly, separating the maxillaries above, by width of its spine only. Its extremity projects considerably beyond the latter, and its sides are only bevelled to receive them, there being no sutural connection. The spine terminates a short distance beyond the anterior margin of the nares. The anterior extremity bears two teeth on each side, which are smaller than the larger maxillaries.

The *maxillary* bones are long and slender, and widely separated on the palatal sur-

face, in front by the vomers, behind by the nares and palatine bones. They terminate in a narrow process behind, whose extremity is broken in the specimen at my disposal, but which is too slight to have supported a malar arch, unless it were as in the Dolphins. Each maxillary bears seventeen sub-equal teeth. The nostrils are linear and superior, as in Mosasaurus, and if separated by a septum, it was exceedingly slender. A portion of it has been preserved; it appears to be composed of co-ossified nasal and frontal bones. The nares extend to a point as far in advance of the anterior margin of the orbit, as the latter is in advance of the posterior margin of the post-orbitals. The *prefrontals* are largely developed and margin the posterior part of the nares. Their posterior exterior margin projects strongly in the plane of the muzzle, and has caused the orbit to be horizontal, and the range of vision vertical, as in some aquatic serpents.

The *frontal* is a wedge-shaped flat bone. The post frontals are large, flat and prominent, and project beyond the process they send posteriorly to join the squamosal. Posteriorly it embraces a broad rectangular process of the parietal, which contains near its front suture, the parietal fontanelle. The projection is considerably wider than as represented by Goldfuss in the genus Mosasaurus.

The *parietal* has two broad lateral wings, which advance on the frontal, and form posteriorly the broad anterior margin of the temporal fossa. The parietal crests are separated by a plane which is narrowed posteriorly. Two antero-superior projections of the supraoccipital embrace it on each side below the crest, while it is overlapped just below, by the anterior extremity of the proötic; this does not extend so far forwards as the supraoccipital. In front of, and below this point, the parietal is decurved, and forms a considerable part of the lateral wall of the cranium; though with but moderate antero-posterior extent. The plate, as preserved on one side of the specimen, has extended to the body of the sphenoid, where extensive sutural surface has received it. I can find no suture crossing it, and it is apparently all alisphenoid or all parietal. I incline to the former view, for where it is separated at its superior base from the parietal, the appearance is quite as similar to suture as fracture. A part of the parietal is, however, undoubtedly decurved in front of it. The structure is quite as Crocodilian as Ophidian in this point.

The anterior ala of the proötic overlaps this alisphenoid largely. Its posterior lamina does not quite meet the expansion of the exoccipital on the upper face of the suspensorium, as it does in Mosasaurus. Inferiorly it is contact with outer and posterior base of the sphenoid.

The *supraoccipital* is somewhat crushed; it is slightly roof-shaped, but not so much so as in M. missuriensis, nor so much below the plane of the parietals as in that genus. The posterior extremity of the parietal appears to rest upon it without sending arches to the opisthotic.

The *exoccipital* is distinct, and bears a very small segment of the occipital condyle.

The *opisthotic* stands obliquely upwards and forwards, and furnishes a glenoid cavity for the articulation of the quadratum. It has a process directed upwards and forwards, which occupies a concavity on the inner face of the squamosal, which has the same direction.

The *squamosal* is flat below, and proximally presents a longitudinal external angle; medially it is more cylindric, and receives the posterior process of the post-frontal.

The *basioccipital* presents a strong transverse condyle. It is a massive bone, and presents infero-laterally two powerful processes which diverge posteriorly, and present broad, rugose, ovate faces of insertion. There is an obtuse keel on the middle line below, which bifurcates posteriorly to each of the lateral processes. The distal portions of these processes are overlapped by corresponding cup-like processes of the basi-sphenoid.

The *basi-sphenoid* is distinct from the basioccipital, and underlaps the latter almost to its middle. It is longer than broad, and sends two processes latero-anteriorly to support the pterygoids. These are not so long as in most Lacertilians. Latero-superiorly it presents a broad surface, on each side of the brain case, for support of the upper side walls. Postero-externally, the proötic rests. It thins out anteriorly, and has overlapped the alisphenoid. The suture for this bone widens anteriorly; inwardly it is elevated into a low crest of the sphenoid.

The *presphenoid* appears to have been distinct; its base was small; it is lost.

The floor of the cranial cavity indicates that the medulla oblongata possessed the downward flexure characteristic of Reptiles, but it does not take place till the middle of the length of the basioccipital is reached. The posterior margin of the sphenoid is marked by a deep pit; its median floor is a transverse elevation; it there descends again and terminates in a deep longitudinal groove.

The roof of the brain-case is marked on the parietal bone by two obtuse divergent ridges, which leave its posterior margin, and embrace the fontanelle. The grooves for the olfactory pedicels are narrow and well separated, but they unite and are entirely enclosed by inferior processes of the frontal bone, as in serpents and Varani. These ridges separate, and leave the bulbi exposed below. Behind and between the nares the median ridge again appears separating two strong grooves.

The *vomer* is divided, and is composed of two slender compressed bones in contact; they are broken off posteriorly.

The *o. o. palatina* terminate anteriorly opposite the posterior margin of the bony nostrils; they are widely separated on the middle line, and closely united posteriorly with the pterygoids. The suture connecting the two runs outwards and backwards.

The *pterygoids* are both wider and longer than the palatines. Their inner margin is curved inwards and upwards—the outer thinned away. They narrow gradually posteriorly, the outer margin bordering the bases of the teeth opposite the ectopterygoid. The latter is attached to a strong external transverse process of the pterygoid. It presents an inferior angulation and bends anteriorly, where it is so thinned out as to suggest its discontinuance. The transverse process is continuous with an upper plane of the bone, and spreads from the upwards rolled inner margin. The posterior parts of both pterygoids are broken away. There is no scar or fossa for columella.

The *ossa quadrata* are preserved and in good condition. There are two concave faces, the largest directed inwards, and the lesser directed outwards and backwards. The bone sends forwards a broad ala, with convex crenate margin, which bounds the larger. The meatus pierces or is enclosed by the outer, by the posterior curvature of the supero-posterior process. The superior articular surface is much more extensive than the inferior, and is tripodal; the posterior branch articulates with the opisthotic. The inferior articular face is sub-transverse, or directed forwards and inwards. It is constricted in the middle, the outer portion the smaller.

The cotylus of the mandible is also obliquely transverse, the inner portion deeper in order to receive the large condyle of the quadratum.

The *mandible* of course partakes of the exceedingly elongate form of the cranium, relatively exceeding Mosasaurus in this respect.

The fossa for the temporal muscle is large and deep, but without inner wall. The coronoid process elevated, convex and rugose interiorly, and with a deep longitudinal groove exteriorly. The superior margin of the coronoid bone is concave, and broad. The dentary terminates in a peculiar striate plug posterior to the last tooth. The distal third or less, is strongly grooved for Meckel's cartilage; proximally this is concealed by the very long laminiform splenial.

The *splenial* is largely developed on the outer face of the ramus, where it articulates with a bone whose homologies are somewhat uncertain.

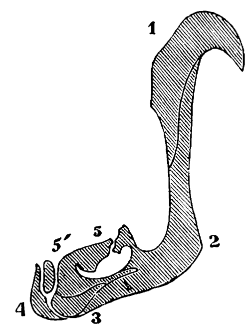
The *subarticular* has a narrow and inferior exposure on the external face of the ramus, and meets the angular just in front of a point opposite the anterior margin of the glenoid cavity. Interiorly it is a little more elevated, but only opposite to the coronoid process: behind and above this it is restricted by the long anterior process of the angular. Anteriorly it is terminated by the squamosal suture of what may be the splenial, just below the first rise of the coronoid process.

The *angular* furnishes the floor for the cotylus for the quadratum. Inwardly it is concave longitudinally, but does not send any horizontal process inwardly: its angle is obtuse; above broad and oblique. Exteriorly it gives way to the large articular. In-

wardly it is prolonged, forming the lower margin of the internal fossa, and then passing between the coronoid and articular. A third laminar prolongation extends to beyond even these, between the plates of the splenial.

The *articular* is the largest bone behind the dentary. It is convex externally, and sends a longitudinal ridge from the cotyloid cavity to that of the coronoid, thus enclosing a large shallow fossa.

Fig. 50.



1 Coronoid.
2 Articular.
3 Subarticular.
4 ? Splenial.
5 and 5′ Angular.

The accompanying cut represent a section of the ramus, about two inches behind the inferior articulation and some distance behind the commencement of the coronoid process. It is also near the distal extremity of the subarticular and the proximal of the ? splenial. The two portions of the angular 5 and 5′ unite a short distance anteriorly beneath the ? splenial.

In the splenial articulation the posterior bone presents the condyloid, the anterior the cotyloid face. The former narrows and retreats upwards and backwards. The articulation allows of a rotary motion inwards and upwards, the alveolar margin of the dentary bone being thrown upwards and outwards. This motion is permitted by the laminar character of the overlapping margins of the splenial, etc., as follows:

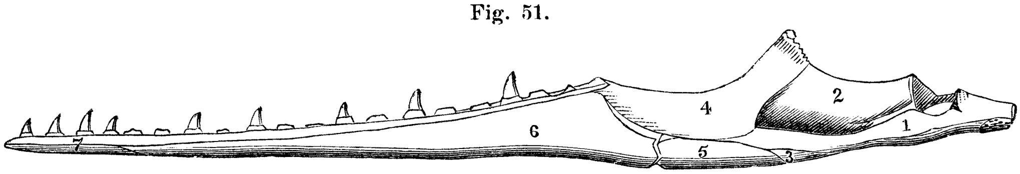
The principal body of the dentary comes to an obtuse but grooved posterior termination. Its external wall is prolonged more posteriorly, the inferior margin fitting a rabbet of the outside of the splenial. The superior margin of this thin plate is much lower than the truncate extremity, and its margin gradually rises to meet the outer margin of the latter. The section of the splenial is U-shaped, much thickened at the turn. The inner lamina is more elevated than the outer, and is concave, turning outwards above to conform to the dentary. A narrow laminar prolongation of the angular is observed between the folds of the U. An outwardly convex, wedge-shaped terminus of the articular, is included between the inner lamina of the coronoid and the outer lamina of the dentary, moving freely on the latter. There is, then, nothing that prevents this from being a complete articulation, except the angular lamina, which is about half a line in thickness, and probably flexible in life.

The superior margin of the coronoid is convex outwardly, and is not continuous with that of the dentary, where the elements forming the splenial articulation are in line. When, however, the process of the articulation is properly applied to the dentary, and the coronoid and splenial are in line, as they no doubt were under ordinary circumstances in life, the curvature of the upper margin of the ramus is continuous and normal. At

the same time the splenial articulation is strongly flexed, and the inferior outline of the ramus angulate at that point.

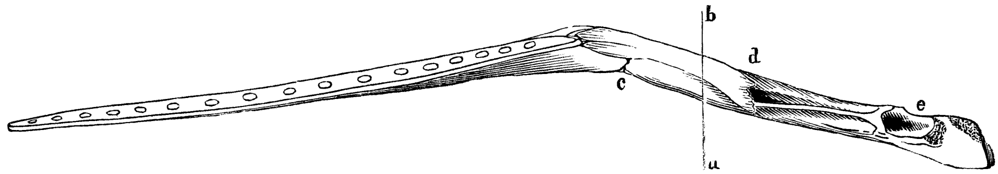
We have in this feature one of the most extraordinary peculiarities of this remarkable genus. The mandibular arch in its usual relations enclosed a diamond-shaped area, open behind, the portion anterior to the lateral angles the longer, and only closed by ligament in front. The structure is an element of weakness, though indeed without such an articulation, such a light and slender jaw would be particularly liable to fracture. There was, no doubt a strong ligamentous union of the parts, as the grooved adjacent margins testify, but for any supernumerary muscles to flex the dentary bones, I can find no provision.

Fig. 51.



1 Angular.
2 Articular.
3 Subarticular.
4 Coronoid.
5, 6 } Splenial.
7 Dentary.

Fig. 52.



The accompanying cut shows the appearance of the normal flexure of the ramus. The line *a b* is that which exposes the section given on a preceding page; *c* is the splenial articulation; *d* the coronoid process, and *e* the quadrate cotylus.

I am disposed to regard the structure in question as an aid to deglutition, and that when large bodies were to be swallowed whole, they passed between the rami, and were accommodated by a large extensible pharyngeal cavity, and oesophagus. No doubt some remarkable habit was possessed by the animals thus characterized, with which we will with difficulty become acquainted.

There is one point in which the composition of the articulation differs from that of Eryx and other serpents with which I have compared it. Instead of being formed in its posterior member by the subarticular bone, that bone with a portion of the angular is sheathed by one more external, which by its position and form, appears to be the posterior extremity of the splenial. If, as is probable from a careful study of the parts, this is the case, the splenial must be regarded as a divided bone.

The cut of the inner face of the right ramus, expresses the relations of these pieces. Size, $\frac{1}{3}$ nature.

The *teeth* are numerous, they are miniatures of those of the Mosasaurus, in most respects. Those of the pterygoids appear to be less compressed than the maxillaries; all have large pulp cavities, though they are restricted by peripheral ossification, as in other genera.

The *palatines* have not united on the median line, and it would appear that they were not in contact. They have a broad longitudinal groove anteriorly. They have no teeth. The *pterygoids* are largely developed. They are widest anteriorly; they present a thin free edge externally and a thick reverted margin interiorly; the tooth series is nearer the outer than the inner margin. The ectopterygoid rises from a strong lateral process of the pterygoid. It represents an obtuse process downwards and a thin process anteriorly. Its position is below the middle of the postfrontal. It is very doubtful whether it had other than ligamentous connection with the maxilliary, as it is far removed from its extremity.

The *vertebrae* in this genus are more numerous than in Mosasaurus, while the number of cervicals bearing hypapophyses is less. The caudal diapophyses are reduced to small knobs, and disappear on some of the anterior of those that bear chevron bones. The neural spines of the caudals are much compressed, and have anterior and posterior alæ. On the distal caudals they become cylindric and fish-like. The zygapophyses become obscure, and finally disappear; before doing so the posterior acquire an up rather than a down-looking face.

The centrum of the atlas is entirely below the very large processus odontoideus. It is keeled below, and has less contact with the condyle than has the processus; the latter is free from the axis, which resembles other cervicals. The odontoid ring is not closed above. The neurapophyses of the atlas are continuous with the lateral segment of the centrum which furnishes articular faces to the basal segment, the odontoid, and to the occipital condyle, and sends a process back alongside the axis. The neurapophyses are slender; if they have a neural spine, it is lost. They are, on the whole, much as in Mosasaurus, and in Varanus.

The ribs commence immediately behind the atlas, if the forms of the diapophyses and their articular surfaces are to be relied on. The diapophysis of the axis is nearly horizontal, descending a little anteriorly; the posterior portion of its extremity is subtruncate for articulation to a small rib. The same part of the diapophysis of the third is more prominent, is ovate, and continuous with a subhorizontal ridge with articular-like surface, which extends to the rim of the cup. The fourth is similar, but the articular faces are more similar in widths and lengths. The inferior limb becomes regularly shorter and less horizontal posteriorly. From the eighteenth to the twenty-third the surfaces are a little smaller, and without apparent difference in size and form. The rib-bearing surfaces posterior to this point are lost.

The form of the centrum presents one marked peculiarity. The superior rim of the cup is excavated for the passage of the spinal cord, and the ball is concave on its superior aspect, appropriately to the same. This is marked on cervicals and dorsals, and faintly indicated on proximal caudals. There are no ridges on the centrum. There is a gradual increase in length from the cervicals to the dorsals and lumbars. Those in the proximal caudals are much like the same in Mosasaurus, that is, rounded below, and with three superior faces, the lateral being the longest. The distal caudals are much compressed.

The neural spines of the cervical vertebræ commence about opposite the notches between the zygosphens and zygapophyses, and are attenuated anteriorly; they are stouter behind. The ninth, (the first preserved), and probably those anterior, have an acute edge behind as well as before. No neural spine is perfect among the dorsals, but on the fifteenth the position is preserved .75 the length of the centrum; the thinness of the broken edge would indicate that there had not been as much lost. The posterior edge is nearly opposite to the ends of the zygapophyses; its posterior slope is considerable. They are evidently shorter than in Mosasaurus.

The neural spines of the caudals are various. The more anterior are thicker behind and alate in front, narrowing to the tip. The median are of similar form, but equally alate anteriorly and posteriorly. The more posterior are much narrowed at the base, and present only the alæ towards the extremity; the last are not wider than the haemal spines.

The chevron bones have been at an earlier age separated from the centra, but as in Platecarpus, they are entirely coalescent with their bases. In Mosasaurus the separation persists. They have two short haemapophysial limbs, and a very long tapering spine, which is grooved in front. On a middle caudal, it is much longer than the centrum and neural spine, and as long as 4.5 centra adjacent. All the haemal arches are directed obliquely posteriorly. No vertebræ without them have been preserved.

Hypapophyses exist on the ten cervical vertebræ. As in Mosasaurus, their extremities are concave, and are articulated to distinct bones which represent a distinct hypapophysial ossification. These bones may be compared to short, compressed ungueal phalanges. The articular extremity of the first is nearly plane, of the others conic, with antero-posterior enlargement. They are directed posteriorly, and have a broad obliquely ovate outline on the lateral view. Their extremities are rugose.

The *ribs* commence at the axis, which has borne a small one. There is no distinct parapophysis, hence each rib-head is undivided, but is flattened vertically. The anterior may be known by the greater compression of both head and shaft. The rib of the third vertebra has a narrow, convex, articular surface, and is concave on the anterior face. That of the fifth is much wider, and with more truncate head. That of the sixth was found

adhering to the matrix on the body of the same vertebra. That of the seventh is wider than that of any of the dorsals, but is compressed like those preceding. The length of the shaft is nearly equal to that of the centra of the 6th, 7th, and 8th vertebræ, the two being proportioned as 17 to 20.

The heads of the dorsals are a slight kidney-shaped oval, with a shallow median concavity. On the tenth vertebra, the head is much shortened and concave medially, on the posterior face. The concavity is posterior on several vertebræ in advance of this point. The form of the shaft of the ribs is proximally, broad above, and narrowed below, *i. e.*, concave wedge-shaped in section. The superior face turns over to the posterior, and is lost in it, and the shaft becomes cylindric. The distal extremities of the seventh cervical and of two of the dorsals, the only ones preserved, are deeply concave with a sharp edge.

The limbs in this genus are of remarkable form. Unfortunately, no metacarpals or phalanges have been preserved. There are the remaining bones of one side and a portion of those of the other. The proximal portion of the left scapular and both coracoids also remain. The right *coracoid* is crushed and adhering closely to the ninth, tenth and eleventh vertebræ, its glenoid cavity apparently in its normal position opposite the middle of the eleventh. Thus the distance of the limbs from the head is apparently ascertained. The external margin of the anterior part of this element is parallel to the vertebral axis in place; the posterior corresponding margin much incurved and thinned out to an acute edge. The anterior portion is more prolonged than the posterior, while the inner margin forms a regular curve without emarginations. The most extensive articular margin is the inner, with the scapula; it is suture-like, corresponding to a singularly indented margin of the scapula. Inside of its anterior margin a moderate foramen pierces the plate. The lower articular margin is lobed, the posterior lobe being the outline of the glenoid cavity.

The greater part of the *scapula* is lost; it has apparently had but little expanse posteriorly, where the margin is thick and little curved. The anterior part of the plate is thin and much produced, I suspect into a pro-coracoid or acromial process. It resembles the basis of Cuvier's pubis of Mosasaurus, which bone I suppose to be the scapula of that genus. In the present animal the anterior margin is strongly incurved and acute, and does not reach the articular face, but bounds a rough triangular projection in front of it.

The *humerus* is a singular bone, and unlike that of any other animal; it approaches nearest that of Sphargis. It is a short, wide, flattened bone, distally as broad as long, proximally a little narrower, contracted medially, with such prominent muscular insertions as to give it four process-like angles in its plane, and two others projecting posteriorly from the head. The articular extremity presents an elongate oval facet for the ulna, and a semi-discoid one for the radius. The *radius* is, in accordance with this, flat anteriorly and convex posteriorly at its proximal extremity; its shaft is very short, and the distal

portion flat; its outline describes nearly half a circle, of which the inner portion only is thickened for the articular face of a carpal: the outer distal angle is thus directed backwards, towards the humerus. The humeral articular extremity is a single transverse plane.

The *ulna* is broader proximally than the radius, but not so expanded, the extremities being of nearly equal width. The extremities of ulna and radius are well separated.

Three *carpal bones* appear to belong to the first row. They are flat and oval, the ulnar the thickest, the radial the largest; the intermedial has six articular faces, and a marginal border, which was, I suppose, posterior, and completed the inter-osseous space in front. A fourth bone, which belongs either to the second series or to the metatarsals, is elongate ovate with straight parallel borders, both quite thin, the inner the shorter; extremities thickened, rounded inwards. The position of this bone has been, therefore, longitudinal.

It is probable that the fore-limb was long, though the proximal portions are so much shortened. The powerful muscles of the humerus would otherwise be without object. These muscles, with the peculiar form of the humerus, probably prevented any appearance of an arm in life, and the hand would be nearly sessile.

There are no remains of hind limbs, though there is no sufficient evidence that they have not existed.

There are three species of the genus Clidastes known to the writer, which differ as follows:

Eleventh vertebra (or the first without trace of hypapophysis) with total width to length as 1 to 1.33., the inverted centrum roof-shaped, elevated; width (total), 2 in. 3 lin. Large. C. IGUANAVUS.

Same vertebra with width to length as less than 1: 2; inverted centrum, lower, more broadly rounded; total width, 1 in. 6 lin. Small. C. PROPYTHON.

The generic characters are almost entirely derived from the second species named.

CLIDASTES IGUANAVUS, *Cope*.

Proceed. Acad. Nat. Sci. Phil. 1868, 223. Geological Survey, New Jersey, Cook, App. C.

In this species the articular face of the zygosphens is inclined at an angle of 45°, while that of the zygapophysis is a little more horizontal. The posterior zygapophyses are broken off.

The convex articular face is nearly vertical, meeting the lower plane at a slightly less angle than the upper. It is much more strongly convex transversely than vertically. The neural arch rises from the anterior three-fourths of the centrum, the zygapophysis coming off from the edge of the cup, and the diapophysis from .2 of the length behind it. The zygapophysis is more prominent than the zygosphen, and the sinus between them is floored by a thin horizontal plate at its fundus.

The general form of the vertebra is depressed. The inferior face of the centrum presents a median obtuse ridge, and nearly flat lateral faces, which are concave antero-posteriorly. The cup is broader than deep, and has a slightly concave outline; the base of the zygosphen originates opposite the middle of the neural canal. The latter is a broad vertical oval.

	In.	Lin.
Length of centrum below,	2	0.5
Width of cup,	1	6.
Depth " "	1	1.5
Width between extremities diapophysis,	3	0.5
Depth articular face diapophyses,		10.5
From diapoph. to end zygapophysis,		9
Between zygosphen and zygapophysis,		4.5
Width centrum anterior to ball,		15.
" of neural canal behind,		5.5

This vertebra indicates a formidable snake-like animal, which paddled and sculled in the Cretaceous Ocean, or perhaps wandered more or less on land. Its length by comparison with the C. propython was probably thirty feet.

From the lower bed of Cretaceous Green Sand at Swedesboro, N. J. Discovered by Professor O. C. Marsh, of Yale College.

CLIDASTES INTERMEDIUS, *Leidy*.

Proceed. Acad. Nat. Sci., January, 1870.

This species is established on several cervical and dorsal vertebræ, with portions of mandibular rami and other bones, from Alabama, discovered by Dr Nott, of Mobile.

They indicate a species intermediate in size between the two others here described. The dorsal vertebræ are rather slender, more so than in C. iguanavus, and with articular faces with cup and ball remarkably oblique to the axis of the vertebra. The dense layer of the bone is thrown into numerous rugosities and ridges, as in C. propython.

What is more characteristic, is the robust and even swollen form of the crowns of the teeth, and their slightly rugose enamel for the basal three-fourths the height. There are no facets.

Rotten Limestone Upper cretaceous, of Pickens Co., Alabama.

CLIDASTES PROPYTHON, *Cope*.

Bost. Society, Nat. Hist. Proceedings, 1869, p. 258.

This species is known from an almost complete skeleton, found by Dr. Edward R. Showalter, in the Rotten Limestown, near Uniontown in Alabama.

Its general proportions may be estimated as follows. As a considerable number of vertebræ has been lost, it will be necessary to illustrate it in some points from Cuvier's estimate of the length of Mosasaurus giganteus.

M. giganteus.			C. propython.	
	2	Atlas and Axis	2	
	11	Cervicals with hypapophysis,	6	
	5	Dorsals with zygapophyses and ribs,	15	
		At least to be added to this series,	10	
18		1 Total		33
64		2 Between the last and those bearing chevron bones, (estimated for C. propython),		96
51		3 Caudals with chevron bones,		60
133		Total,		189

Where the dorsal series of the Cl. propython is interrupted, the vertebræ have increased in thé strength of their processes rather than diminished, and I consider an addition of ten to be below rather than above the mark. Of the caudals there are preserved forty-four, all with the chevron bones, and none with diapophyses. I have added nine for those without chevron bones, while the interruptions in the series readily justify the addition of seven more. The lost series is estimated from that of the M. giganteus, adding relatively to the increase observed in the series preserved. The length may be estimated as follows:

	Inches.
Of the cervicals and dorsals (average),	$37\frac{1}{8}$
Remaining vertebræ with diapophyses,	90
" " without "	30
The cranium,	$14\frac{1}{2}$
Total, fourteen feet, $3\frac{5}{8}$ inches,	$171\frac{5}{8}$

The ophidian character of the vertebræ, however, leads me to suspect that the length will be hereafter found to to be considerably greater. The relative length of the cranium above given, is not greater than in the Iguana, while its dimensions, as compared with the cervical vertebræ, are not relatively greater than in the existing serpents. If the Ophidian characters, therefore, were as strongly exhibited in the vertebral series as I suppose, the length would be twenty feet, at the least.

The discoveries with reference to the vertebral column of the M. missuriensis prove Cuvier's estimate to have been much too low; while Goldfuss' estimate for the former is probably as much behind nature as Cuvier's is behind it.

The cups and balls are transversely oval, or slightly heart-shaped, and the centrum expands gently to the edge of the ball. The latter is surrounded by a strong and wide groove except at the bottom of the neural canal. The extremital parts of the centrum are delicately striate, while the distal parts of the diapophyses and zygapophyses are very rugose throughout the whole length of the vertebral column. This portion terminates by a slight rim round all the articular faces. The neural spines of the dorsal veretbræ or the parts preserved, do not present rugosity, but those of the caudal vertebræ are striate to the anterior and posterior margins, and are distally deeply grooved, the grooves meeting on the median line in front. The end of the spine is truncate, and longitudinally ovate; like the ball of the vertebra, it is surrounded by a groove, and below this by a smooth space above the extremities of the grooves. The knobs representing diapophyses are very rugose.

The diapophysis of the axis is horizontal, the posterior position is directed upwards in the fourth, and is nearly vertical on the fifth, forming an L-shape with the inferior portion. On the seventh the latter is first shorter than the now vertically elongate superior extremity. On the tenth it first ceases to reach the rim of the cup, and on the eleventh it is no more prominent than the upper posterior angle of the vertical face, giving it a slightly sigmoid form. The diapophysial face now regularly shortens; on the fourteenth its length is equal to its projection from the centrum below.

The chevron bones are likewise striate, the hæmapophysial portions very delicately, the spinous portions coarsely. The striæ cease abruptly near the tip, which looks like that of a rough stick which has borne a ferule. The hinder face of this portion is grooved, but not so largely as the front; the branches present an angle on their inner anterior aspect.

	Lines.
Length axis,	18.8
" " without proc. odontoïdeus,	14.8
Width of diapophyses,	16
" " ball,	7.5
Depth " "	6
" centrum and attached hypapophysis,	10.3
" same with free hypapophysis,	14.3
Length of " "	8.3
" " sixth cervical, centrum (without ball),	12.3

	Lines.
Length of sixth cervical, neural arch,	13.6
Width at narrowest point of " "	8
Expanse of zygosphens,	4
" " zygapophyses (anterior),	13.2
" " diapophyses,	19
Width cup,	8.5
Depth centrum and both hypapophyses,	14.8
Length free hypapophysis,	5
" centrum (incl. ball) of twenty-third V.,	16.8
" neural arch,	16.6
" between anter. zygapoph. and diapoph.	7
Depth diapophysis,	5.3
" neural arch and centrum,	14
Width centrum (least),	7.5
" ball,	9.3
Depth "	7.8
Length of an anterior caudal (no diapoph.),	7.2
Width cup,	8
Depth,	7
Total depth centrum and spines,	54.8
Neural spine and arch,	16
Antero-posterior width base spine,	7.2
Length of 13th caudal from the last,	5.8
Width cup,	7
Depth "	5.8
Length distal caudal,	3.4
Width cup,	2.3
Depth "	3.

The form of *the cranium* is that of an elongate flat wedge. The lateral outlines are slightly contracted just behind the anterior opening of the nostrils. A deep emargination occurs at the orbits, while the temporal fossæ interrupt the outline more deeply still. The projection of the opisthotic and squamosal is about as extensive as that of the post-frontal. Throughout, the surface from muzzle to occiput is quite plane, though the latter region has been evidently slightly crushed, and the posterior median frontal region is slightly concave. Transversely, there is a strong concavity, with vertical inner margin on each side the median parietal region. The post-frontals are slightly decurved, the pre-frontals still less so. The nasal region would be plane transversely but for two shallow longitudinal grooves, separated by a low raised line which extends from the middle of the front along the nasal septum.

A section of the muzzle in front of the nostrils would be a semi-circle; posterior to this point the sides of the maxillaries are more vertical. The edges of the projecting orbital bones are thin, as well as the orbital rim of the frontal. The inner margin of the maxillaries is very thin and rolled over the outer margin and extremity of the thin pre-frontal. The bones are all relatively more fragile than in Mosasaurus. The posterior process of the post-frontal, which is received into a groove on the inner face of the squamosal, is sub-trigonal.

The parietal crests are the lateral angles above mentioned. They are nearly parallel behind, and diverge gently in front; they then diverge still more, and extend along the suture between the parietal and frontal bones, and then disappear. There are no other ridges on the cranium, except the median occipital, which is low.

The premaxillary and anterior maxillary *teeth* are more rounded than the posterior maxillaries. The former have an angle separating inner and outer planes, in front only, the latter, commencing at the sixth maxillary, on both anterior and posterior lines. In the tooth named, the inner face is the more convex and extensive; there are no facets

on any of the teeth. The apex curves gently inwards. From the above, the greater compression of the posterior teeth may be inferred.

The pterygoid teeth present no cutting angles, and are gently curved backwards. Like the maxillaries, the anterior mandibular teeth have no posterior edged angle, but they have one on the posterior part of the outer side, dividing the crown into two very unequal faces, the inner being much the larger. This ridge becomes more posterior in the hinder teeth, but the outer facet is never larger than the inner. The crown is faintly ribbed, but not so as to be facetted, as in Holcodus and Mosasaurus. Number of teeth on each side: premax., 2; max., eleven functional, and alveolæ in intervals for six more; mandibulars, fifteen, with alveolæ for three others.

The usual vasculo-neural foramina occur along the faces of the maxillary and dentary bones. The series of the first commences by two small ones, one above the other, near its extremity; this is followed by a close series, there being three opposite two adjacent alveoli. They are soon more widely spaced, and number sixteen altogether. There are eleven on the dentary bone, quite widely spaced behind; the anterior small.

The *cranial bones* are all minutely striate, the upper surfaces of the parietal and occipital most strongly. The coronoid process is very rugose on the inner aspect; as are the posterior margins of the angular, up to the terminal line, where would appear to have been a band of cartilage similar to that at the articulation of the ribs, or like the ends of the caudal neural spines. The sutural margins of the angular is marked by delicate radii. The external surfaces of the mandibular bones are minutely striate, like the bones of many fishes.

The proximal part of the internal lamina of the splenial is concave. It does not extend to the end of the ramus, so that the meckellian groove is open for one-fourth the length of the latter. The outer face of the ramus is regularly convex. The splenial disappears from view at a point opposite the fourth tooth from behind. The inferior ridge of the mandible is straight to near the splenial articulation, where it is directed slightly outwards. On the proximal part of the mandible, it is gently convex inwards to nearly opposite the anterior part of the quadrate cotylus, where it is convex outwards; the plane of the angle is then directed slightly inwards, and is very rugose below.

When in position, the plane of the proximal part of the ramus is more horizontal than that of the distal. From the splenial joint the inferior margin becomes more horizontal, until the broad angle is nearly transverse, and with a slight inward curve. What appears when examined separately to be the external face, becomes largely inferior, making an angle of 45° with the horizontal.

The fossæ are strongly marked. The outer edge of the coronoid rolls back, and the upper edge of the articular forms a ridge, enclosing the internal fossa. The quadrate cotylus is sub-longitudinal, inclining inwards and forwards, and with a high anterior margin.

Measurements.	*In.*	*Lin.*
Length from end muzzle to occip. condyle,	14	4
" " " " parietal fontanelle,	11	3
" " " " poster. extrem. nares,	6	6
" " " " end maxillary,		11
" " " " " malar process do.,	9	6
" " " " pre-frontal angle,	8	11
" " " " post-frontal "	11	9.5
" (median) temporal fossa (antero-posterior),	1	9
Width at anterior extrem. maxillaries,		9
" " pre-frontals,	4	1
" " post-frontals,	5	
" between poster. extrem. squamosals,	5	1.2
" " anter. extrem. proötics,		16.3
" " parietal crests behind,		5.5
" " " " at parietal fontanelle,		14.3
" of suspensorium,		6.7
" " septum narium at poster. extrem.,		7.2
Length suspensorium (without squamosal),		19

	In.	Lin.
Length basi-occipital,		13.7
" sphenoid (oblique),		17
Width of basi-occipital condyle,		9.9
" between basi-occipital processes,		17.3
" of sphenoid medially, below,		10.3
" between processes of sphenoid,		13.5
" of quadratum antero-externally,		15
" " postero- "		9
" " (greatest) quadratum, condyle,		13.3
" " meatus auditorius,		2.4
Length quadratum,		18.5
" ramus mandibuli,	15	8
" to splenial joint,	10	2
" to coronoid process,	12	4
" to cotylus (anterior margin)	14	4.5
Width of angle at base,	11	3
Depth at coronoid process,	2	
" " splenial joint,	1	6
" " at twelfth tooth,		10
Length of o. palatinum,	2	10
Width " "		11
Length pterygoid to transverse process,	4	6.4
" transverse process,	1	3.5
Width pterygoid at do.,		6
" " " palatine suture,		12.5
Elevation mandibular tooth above dentary,		5.6
" crown only,		5
Antero-posterior diameter crown do. at base,		3.2

The lateral processes of the basi-occipital are ovate, broadly behind, and narrowed anteriorly; they are flat-faced, and marked with concentric rugæ on the same; they are connected by a cross-ridge, which forms the boundary of a median obtuse ridge in front of it. The sphenoid is marked by two weak parallel median ridges. Its lateral margins project and are angulate. The anterior processes for the pterygoids are flat, and obliquely transverse. The articular faces are directed but little forwards.

There are seventeen teeth on each pterygoid, the posterior smaller and more closely spaced. The anterior tooth is close to the suture with the palatine. The tooth series is everywhere nearer the outer than the inner margin. The palatine suture extends forwards and inwards. Anteriorly the inner margin is more prolonged than the outer, and is connected with it by a concave margin. The surface of the bone is concave medially and elevated on the inner and outer margins.

The vomers each have an elevated middle line, which produces two longitudinal ribs on the median line, as in many lacertilians. Their surface is not striate.

The scapular arch is only represented by scapula and coracoid; the other elements, if existing, have been lost. The convex margin of the coracoid is very thin, thickest posteriorly. The outer anterior margin has two angles, one above and one below, the former running out on the plate.

The two extremities of the *humerus* are in nearly the same plane, the inferior condyle being directed backwards from it. The head is thick, with superior and inferior tuberosities more prominent than the articular face. The latter is especially large, acuminate anteriorly, and the bordering portions of the shank coarsely striate. The greater tuberosity projects posteriorly; its margin is convex. It is separated by a deep groove from the lesser tuberosity, which is equally prominent, but much narrower and more prolonged on the posterior face of the bone. It occupies the summit

of a ridge which disappears opposite the superior or condyloid tuberosity. The latter is small, but very prominent, and with striate sides. The articular facets for the radius and ulna, form together a curve. The inferior condyloid process is the most prominent and massive of all, the smooth extremity sub-triangular, acuminating to the ulnar articution. Its sides are rugose.

While the proximal extremities of the *ulna* and *radius* are not in exactly the same plane, the distal are; the ulna is the twisted bone. It has a tuberosity in place of an olecranon, which is not very prominent; it is partly covered by a reflected portion of the area capped by articular cartilage. Distally there are three articular facets, the middle the largest. This with the inner seem adapted to the ulnar and intermedial carpals. The radius has but one articular face distally. It is a very wide bone, expanded into a semi-disc, which increases the width of the paddle, and consequently the natatory power. Both these bones are striate near the articular surfaces, and most so proximally. The posterior face of the proximal end of the ulna is the concave one; of the radius, it is the convex.

The *radial carpal* is the largest of the first row. It presents a free edge towards the inter-osseous space, which is exceedingly short, and margins a prominence in the otherwise oval outline. There are two distal articular facets, and one interior. The bone I have supposed to be the intermedial is concave on the inter-osseous face, and presents two sub-equal distal articular facets, one shorter superior, and two inferior facets. The ulnar carpal is thicker than the intermedial, but not large, and considerably smaller than the radial. It has two distal and one superior facet. All the carpals are delicately striate, but not medially—only near and at right angles to the articular facets. The outline of the inter-osseous space is a wide elongate oval, not quite symmetrical.

	In.	*Lin.*
Length from head humerus to second row carpals,	3	6.8
" humerus,	1	9.5
Width proximally,		15.5
" medially,		10.5
" distally,		20.
Thickness head and greater tuberosity,		9.5
Length ulna,		16
" radius,		18.5
Width " head,		9.5
" " shank,		7
" " distally,		19.
" ulna "		11.5
" " shank,		6
" " proximally,		11.5
" inter-osseous space (transverse),		10.5
" carpals first row,	2	4
Length radiale,		11.3
" intermedium,		8.6
" ulnare,		8.3
Width "		7
" radiale,		8.5
Thickness "		3.
Length coracoid (antero-posterior),	3	1.
Width " (inferior),	2	0.7
Length " anterior limb,		20.4
" " posterior "		11.5
" proximal extremity of scapula,		9.5
Diameter (long) of glenoid cavity,		11

The head of the os quadratum furnishes a tripodal cartilage capped face; the anterior, narrowest, is the margin of the large anterior ala; the posterior, the widest and longest, descends behind the auricular meatus, and is curved out-

wards, the outer is horizontal, and corresponds to the prominent ridge in front of the meatus. The ridge connecting the anterior lamina with the condyle, is strongly convex and ridged or crenate round the external margin. The ridge bounding the meatus in front is concave. The condyle is much wider and more convex intero-anteriorly; the remaining portion is narrowed. There is a deep superficial pit just above the meatus. The anterior semi-circular expansion is shallow concave on the inner side.

The form of this element indicates a nearer relation of Clidastes to Liodon validus than to Mosasaurus.

The type specimen of this species was found in the bed of a small stream, where it had fallen from its original position in the bank.

Rotten Sandstone of the upper Cretaceous of Alabama. Dr. E. R. Showalter.

OPHIDIA.

PALÆOPHIS, *Owen*.

PALÆOPHIS LITTORALIS, *Cope*.

Proceed. Acad. N. Sci., Phil., 1868, 234. *Dinophis littoralis*, Marsh, Am. Journ. Sci. Arts, 1869, p. 400.

This is the first serpent whose remains have been found in the United States, in deposits older than the postpliocene. We owe its preservation to D. Knieskern, of Shark River, New Jersey, best known by his botanical investigations. It is in possession of the New Jersey State Geological Survey, and has been submitted to me by Prof. Geo. H. Cook, the Director, for examination. The specimens consist of three vertebræ, neither of them perfect, the most so with neural arch, but with diapophyses broken off.

The more perfect is an anterior dorsal, with two hypapophyses, the anterior small and directed forwards, the posterior larger, and directed vertically downwards. The ball has a considerable superior up-look, though the groove which bounds it is but little oblique. Centrum much compressed behind the middle. Plane of basis of zygapophysis opposite floor of neural arch; zygapophysis directed slightly upwards and outwards, continuous by a broad wing running posteriorly, with the diapophysis. Neural arch well elevated, broken off behind. The basis of the neural spine is narrow on the anterior part of the arch, and does not reach the anterior margin.

	Lines.
Length centrum (ball to edge cup),	8.25
Depth ball,	4.25
Width "	5.
" between extremities of zygapophyses,	8.
Depth cup and neural arch,	7.5
Width neural arch behind,	2.25

A strong ridge extends from the zygapophysis posteriorly parallel with the centrum. There is no ridge continued from the zygosphen, except a slight ridge below the fossa, which is above and back of the diapophysis, the surface of the vertebra is smooth.

Another vertebra is rather broader in proportion to its length, and less compressed.

Length (as above),	7.8
Width ball,	5.

In both, the ball has a sub-triangular outline. In the more perfect, the base of the neural canal is divided by a narrow longitudinal epapophysis.

Locality. The Eocene Green Sand Bed of Squankum, Monmouth Co., N. J.

PALÆOPHIS HALIDANUS, *Cope*.

Proceed. Acad. Nat. Sci., 1868, 235. *Dinophis halidanus*, Marsh, l. c. 1869, 400.

A single vertebra represents this species. It indicates one of the largest of the genus, being little different from the *P. typhæus* of Owen, in size. The bulk of the vertebra is double that of the *P. littoralis*. In addition to this

point, it differs from the latter in the greater transverse diameter of the cup and ball; these are transversely oval; in the *P. littoralis* sub-triangular ovate; the centrum is naturally less constricted and broader in the former. The articular face of the zygapophysis is broadly ovate in the *P. halidanus*, narrowly so in the smaller species; while there are indications of similar posterior hypapophysis in both, the anterior in the *P. halidanus* appears to have been smaller.

As compared with the species described by Owen, the cup and ball are more transverse than in any noticed in the British Fossil Reptiles, approaching that figured by him in Pl. 3, fig. 22–4; the ball has not the oblique, up-looking profile of that species, but forms a nearly regular arc, with its posterior margin superiorly a little behind its position inferiorly. The hypapophysial ridge is considerably interrupted as in the *P. typhœus*, while *P. littoralis* agrees with the *P. toliapicus* in having it continuous. The two last named species differ in the development of their hypapophyses. In the American species both are large, especially the posterior; in the English, the anterior process is weak or wanting; the ridge connecting the zygapophyses disappears in the *P. toliapicus*, continues in the *P. littoralis*. The general proportions of the centrum are slender as in *P. toliapicus*, and not so stout as in *P. porcatus*, Owen.

The diapophyses in the *P. halidanus* are not so pedunculate as in *P. typhœus*, though they are separated above by a notch from the vertical ala which descends from the zygapophysis, which I do not find in the *P. littoralis*. They approach near the margin of the cup in their transverse extent below.

The horizontal ridge between the zygapophyses is strongly marked, and in the specimen in hand comes off from the anterior vertical ala below the zygapophyses, rather than from the plane of that process, as in *P. littoralis*. The neural canal is depressed behind below the margin of the ball, and has an obtuse epapophysis along the median region of its median line. There is no ridge parallel to the hypapophysis. The cup is partially broken, but its transverse diameter appears to have been one-fourth greater than the vertical. The transverse plane of the face of the zygapophysis is transverse. A large part of the neural arch is broken away.

	Lines.
Length from edge cup to convexity of ball,	12.75
Width between anterior zygapophyses,	13.5
" cup,	8.4
Depth "	6.2
Least width centrum at middle,	5.3
Width neural canal,	4.

Locality. This serpent was found by my friend, O. B. Kinne, in the excavations of the Squankum Marl Company, at Squankum, Monmouth Co., N. J., a few miles south of Shark River. The horizon is Eocene.

This animal was probably a sea serpent distantly allied to the Boas, and far exceeding in dimensions the Hydrophidæ at present inhabiting the Indian Ocean. Its size was similar to that of the very largest of terrestrial serpents of the modern era, and was probably proportioned to a length of twenty feet.

Certain ovoid bodies have been found with the above by O. B. Kinne, at Squankum, which look like fossilized dicotyledonous seeds allied to Leguminosites of Bowerbank.

PALÆOPHIS GRANDIS, *Marsh.*

Dinophis grandis, Marsh, Sill. Am. Jour. Sci. Arts, 1859, 398.

The largest species of the genus (if such it be), yet discovered, and represented by a single dorsal vertebra, with the neural arch well preserved. It is thus described by Marsh.

The general form of the centrum is elongate, and considerably compressed behind the middle. The articular cup and ball are sub-triangular ovate, and their faces are much more nearly vertical than is usual in ophidian vertebræ, the cup looking but very slightly downwards. The neural arch is elevated and massive. The neural canal is broader than high, and its floor depressed posteriorly, with indications of a slight medial epapophysis. The sides of the canal are marked by a sharp longitudinal ridge, which, in connection with the arched roof above, gives a trifoliate outline

to a transverse section of the opening, as in some species of *Python*. The floor of the neural canal is somewhat below the plane of the anterior zygapophyses. The zygosphen is much elevated, and its summit concave. It is narrower than the articular cup, a feature which appears to be peculiar to fossil serpents. Its anterior surface is deeply excavated, and the lateral margins extend from the base downwards and outwards to the superior edge of the cup, thus continuing the sides of the neural canal forward. The zygantrum is comparitively shallow, and has its greatest depth on the medial line. Its base extends downwards and backwards until directly over the superior margin of the ball, protecting also from above the neural canal posteriorly. The neural spine is much compressed, triangular in outline at its base, and does not extend to the anterior margin of the zygosphen. The base of the neural arch is strengthened by a thick rounded ridge, which unites the zygapophyses on each side. It begins below the plane of the anterior zygapophysis, and ascending slightly, joins the posterior zygapophysis above the articular face. Remnants of two hypapophyses connected by a prominent ridge exist, and show that the anterior process was much the smaller and its base somewhat separated from the margin of the cup.

The principal dimensions of this vertebra, which is apparently an anterior dorsal, are as follows:—

	Lines.
Length of centrum from edge of cup to convexity of ball,	14.25
Transverse diameter of cup,	9.10
Vertical diameter of cup,	7.5
Distance from top of zygosphen to lower margin of cup,	13.25
Vertical diameter of ball,	7.25
Width of neural canal in front,	3.75
Height of neural canal in front,	2.5

From the Eocene marl of Shark River, Monmouth Co. N. J.

Prof. Marsh regards this and the two species of serpents already described, as representing a genus distinct from Palæophis which he characterizes as follows, "Among the most apparent differences between this genus and Palæophis, to which it is closely related, are the following:—The base of the neural spine in *Dinophis* is not co-extensive with the supporting arch, but rises a short distance back of the anterior margin of the zygosphen, as in the existing *Python*. The ridge connecting the anterior and posterior zygapophyses is much more developed, and its continuous crest more rounded. The sloping sides of the arch above the neural canal are more deeply concave, and an obtuse ridge separates the concavity from the anterior zygapophysial notch. The neural canal has a sharp longitudinal ridge on each side, which gives its transverse section a trifoliate outline, as in *Python*. The zygosphen is more excavated anteriorly, and its summit is concave. The zygapophyses are more extended outwardly, and the hypapophysial ridge is more prominent."

The most important character here cited appears to be the non-coincidence of the base of the neural spine with the neural arch. This character is true of P. littoralis to such a slight degree as to render its importance problematical. The other characters adduced, are of a comparative nature, so that until the limits of the proposed genus, if valid, can be more fully defined, I retain the species in Palæophis.

APPENDIX TO THE REPTILIA.

CROCODILIA,

Bottosaurus, Agass.

Bottosaurus tuberculatus, Cope, Sp. nov.

From an examination of additional material, I am disposed to believe that the Bottosaurus, described under the head of B. harlani, at page 65, as a smaller individual, really represents a different species which I name above. The material is from the same locality as the above specimen, and consists of twenty-seven vertebræ from the dorsal, lumbar, sacral and caudal series, with large portions of the pelvis and both hind limbs, including two perfect femora; also, about fifty dermal bones.

Cranium and teeth. These are described as above. The acute, conic dental crown, which, I at one time referred to the position of canine of B. harlani, I believe to indicate the specific distinctness of the present animal. The specimen of the latter appears to be mature, as one half the neural arches of the vertebræ are coössified; the size is, therefore, not more than half that of B. harlani.

Vertebræ. A prominent character to be noticed is that none of the dorsal and lumbar series has compressed centrum, as is the case with most of the Holopes; nor have any of the posterior dorsals the compression seen in H. obscurus. Second, the centra never present the parallelogrammic horizontal section seen in the Holopes; on the contrary, they are much contracted just in front of the articular ball, and flare out regularly laterally, to the rim of the socket. The lip of the cup is thin, and the cup inclines to narrow downward, especially anteriorly. This is owing to the fact that the inferior median line becomes pinched or narrowed on approaching the position of the hypapophysis. One vertebra with the latter is preserved; the process is broken off, but had a small basis,

	Lines.		*Lines.*
Width cup first lumbar,	21.2	Width neural canal,	7.4
Depth " "	17	Antero-posterior length between ends of zygapophyses,	34
Length centrum,	28.6	Expanse of anterior pair of do.,	45

Width cup fifth dorsal,	20.	Width neural canal	6.8
Depth " "	16.5	Antero-posterior spread of zygapophyses,	33.4
Length centrum do.,	27	Expanse of anterior do.,	38.2

The *Femora* are large in proportion to the size of the vertebræ. The head exhibits the round form characteristic of Holops, and not the obliquity of Hyposaurus. What characterizes it is the great prominence of the ridge, rudimental in the latter, which represents the third trochanter of Dinosauria. This prominence is increased by the presence both anteriorly and posteriorly of a strongly marked pit. Another marked characteristic, not seen in other genera, is the truncation of the posterior margin of the shaft close to the head, down to nearly opposite the third trochanter; the surface thus produced is deeply grooved. Inside of the head roughly grooved; outside flatter, more finely grooved; a grooved swell, in the position of the great trochanter of other forms. The shaft, compared with the Holopes and Hyposaurus, figured in the present work (Pl. IV.,) is shorter and more curved. The condyles are wide, with narrow posterior prolongations extending on each side of a wide and deep popliteal groove.

	In.	*Lin.*		*In.*	*Lin.*
Length of right femur,	10	8	Expanse condyles.	2	8.6
Width head,	2	9.8	Circumference shaft at middle,	4	4.
Length to 3d trochanter,	3	11·7			

The *tibia* is stout and slightly curved; the condyloid extremity presents two articular surfaces at right angles to one another, of which the longer is contracted in respect to the length of the bone, and is supported by a thin margin. The proximal extremity is broken from that of one side, but remains with a part of the shaft of the other.

	In.	Lin.		Lin.
Length (not restored,)	7	11	Diameter median,	14
Diameter proximal,	1	10	" distal,	26

Portions of shafts, etc. of most of the other long bones are preserved.

Both *ilia* remain, one quite perfect. The latter is more prolonged posteriorly than in Cuvier's figure of that bone in *Crocodilus biporcatus*. The anterior half is much like that in a large smooth toothed Holops from Tinton Falls, N. J., but presents a pit just behind the anterior tuberosity not found in it. There is a separate oval articular face below this tuberosity at the usual pubic articulation. The anterior angle of the crest of the ilium is not prominent; more so in the Holops above noted. Crest longitudinally rugose.

	In.	Lin.		Lin.
Length ilium,	6	7	Depth anterior tuberosity,	22.4
Depth behind ischiadic suture,	2	3	Length posterior hook ilium,	32.2
Depth at do	3	5.7		

The *dermal bones* are very characteristic and distinguish the genus. They differ in two points from those of Thoracosaurus and Holops; first, in having no pits; second, in having a prominent median keel. They are rather small, subquadrate, and with a very thick, always obtuse, and sometimes elevated median carina. The latter has rather the form of a knob. Many of the bones consist chiefly of this knob with a small basis. The superior surface is dotted with a few punctæ and grooves. Length of one of the largest 24.1 lines; depth 5 lines; width 11.5. Those probably of the cervical or anterior dorsal region have been described by me under Holops obscurus, p. 78. I believe they should be referred here, as those from the dorsal region of the present specimen approach them very closely. Those referred to the Bottosaurus, p. 66, should be assigned elsewhere.

From the upper bed of upper Cretaceous green-sand New Jersey. Discovered by Judson C. Gaskill, to whom I am indebted for portions two individuals.

Holops, Cope.

Holops basitruncatus Owen, *Crocodilus basitruncatus*, Owen, Journ. Geol. Soc. Lond. V., 1849, 380; Palæontology, 1860, 277; Pictet Traité de Palæontologie, I., 1853, 482. *Bottosaurus harlani* pars Leidy Cretac. Rept. N. Am. Cope huj. op. p. 66.

Specimens referred to Bottosaurus by me, after Leidy, with doubt, appears to me now to represent a true Holops. The vertebræ and bones described under that head in this work, p.p. 66-7, I accordingly refer to the latter genus, as well as fragments of cranium with cervical vertebra from the same localities, referred with doubt to Holops obscurus, and described, p. 77, with cuts 19, 20, of the muzzle. The enamel of the tooth in this species is not fluted.

Holops glyptodon Cope Hujus operis, p. 74.

Two additional specimens of this species, one from Barnesboro and one from Mullica Hill, N. J., indicated that this species is a Gavial of the genus Holops. The character of the fluted teeth is well marked. The median dorsal vertebræ are compressed as in H. obscurus, while some of the cervicals display a prominent transverse crest in front as in H. basitruncatus, and much more prominent and extended transversely than in H. obscurus; size similar to H. obscurus. It may be observed that seven examples of the latter confirm its characters.

Thecachampsa, Cope.

The form of the cervical vertebræ in this genus was left uncertain in Synopsis of genera of Extinct Crocodilia, p. 62. I am now able to state that they possess the elongate simple hypapophyses of Crocodilus, and are quite different from those of Thoracosaurus. The supposed tertiary Crocodile with bifid hypapophyses, mentioned l. c., is from a cretaceous bed in the neighborhood of an Eocene outcrop.

ANOMODONTIA.

Dicynodon Owen.

Dicynodon rosmarus Cope sp. nov.

A species of this genus occurs in the Triassic beds of Pennsylvania, thus completing the similarity between them and the Trias of S. Africa and India in the combination with Labyrinthodonts (Eupelor), Thecodonts (Belodon), and Dinosauria (Clepsysaurus). The species is represented by two shed canine teeth, one specimen represented by the root of the fang only. They indicate one of the larger species, the root being about nine lines in diameter at the basis, the crown rather strongly curved. Section a wide oval, more circular near the apex. Other remains, more characteristic, will shortly be described.

From the "red bed" of Wheatley's section at the tunnel at Phœnixville, Chester Co., Pa., Museum of Chas. M. Wheatley, A.M., to whom I am indebted for the loan of the specimens.

TESTUDINATA.

Adocus, Cope.

Proceed. Acad. Natl. Sciences, Phila., 1868, 235.

Character. Anterior and posterior lobes of the plastron abbreviated, narrowed, and not emarginate. Eight paired sternal bones; twelve sternal scuta, the humerals extending anteriorly, the pectorals and gulars both small. A series of plates, "intermarginals" within the marginals, on the sternal bridge. Rib heads, i. e., the capitula, wanting in the species whose costals have been examined.

This genus was originally described with *Emys beatus* Leidy from the Cretaceous Green Sand of New Jersey, as the type, and its primary character was regarded as the absence of the costal capitula. In the synopsis of extinct reptilia of New Jersey, published in Prof. Cook's Geological Survey of that State, five species were enumerated, as follows: *A. petrosus* Cope, *A. firmus* Leidy, *A. beatus* Leidy, *A. pravus* Leidy, and *A. agilis* Cope. The two species first enumerated having subsequently been found to possess well developed costal capitula; I referred them to Emys, in the present work, p. 126. My specimens of *A. agilis* being at the time very imperfect, it was not described.

At present, I propose to point out its characters, as well as those of the other species of the genus. Two species are added, the whole number being then five. One of these is from the Cretaceous deposits of Wyoming, the others from New Jersey.

The plastron in this genus presents marked peculiarity. The great reduction of the anterior and posterior lobes gives it a form approximating that of Staurotypus. The anal scuta are of large size, and the femoral abdominal scutal suture (in A. agilis) extends across just in advance of the inguinal notch. The abdominal is the widest pair of scuta, in consequence of the relatively great longitudinal extent of the bridge; their anterior outline falls a little behind the axillary notch. The humeral scuta have a remarkable anterior extent, so much so as to lead to the suspicion that they were confluent with the pectorals, or perhaps wanting. In the case of *A. pectoralis*, having only the hyosternal bones, I was induced to think that they were really the pectorals, and that the abdominals were the true humerals, as is seen in the genus Pleurosternum; the posterior position of the humerals in the latter being owing to the existence of an additional pair of sternal bones. An examination of the structure in *A. agilis*, and *A. wyomingensis* dispels this view, and shows that the true pectorals are much shortened, and have an anterior position, and that the gulars are also small and narrowed, the genus approaching Chelydra in these respects.

The lateral series of abdominal marginals is seen in the existing genera Macrochelys and Dermatemys. The affinity of Adocus is to the latter, but the entire acuminate free lobes of the plastron distinguish it well. The lateral marginal scuta in *A. agilis*, *A. wyomingensis* and *A. pectoralis* are very distinct in our specimens, while I have seen it in only one of the two or three in which the bridge is preserved in A. beatus. In A. pravus, I have not seen it, but

the contracted entire xiphisternal elements pointed out by Leidy, are quite like those of A. beatus, to which it is indeed very nearly allied.

The narrowed form of the posterior lobe is best seen in the specimen of A. vyomingensis described by Leidy, and in a specimen of A. beatus, noticed by me in Synopsis Batr. Rept. N. A., p. 129. I there state that it is emarginate, an error consequent on a certain assymetry of the specimen, and its fractured condition. In A. agilis it is apparently rather better developed.

The form of the anterior lobe is easily seen to be narrow by reference to my figure of *A. pectoralis* (Syn. Bat. Rept., N. A., Tab. VII, fig. 1,) or Leidy's figure of *A. pravus*, Cretac. Rept. N. Am. XIX, fig. 1. In the nearly perfect specimen of *A. vyomingensis*, this portion is broken away, but Leidy describes this portion of a specimen which has the charactcr of the above species.

The species differ much in the relative stoutness of their shell, especially of the plastron. A. pectoralis is the stoutest as well as the smallest; A. pravus and A. agilis are the thinnest, the latter the largest of the genus. No portions can be certainly ascribed to the crania of this genus.

In specimens of A. agilis, A. pravus and A. beatus, the longitudinal median suture of the plastron presents much irregularity from the union of the alternating bones across the point of meeting of four, by an oblique portion of the suture.

Thickness of hyosternals less than four lines in the transverse extent of same; intermarginals short; mesosterna prolonged posteriorly, smooth below; small. *A. pectoralis.*

Thickness of hyosternals one-eighth transverse extent of same; above with slghtly impressed dots or delicate grooves, closely placed; larger, vertebral bones wider. *A. beatus.*

Sternum thick; vertebral bones narrower; carapace more coarsely longitudinally impressed grooved; mesosternum deeply received; lateral intermarginals elongate. *A. vyomingensis.*

Plastron quite thin; mesosternal deeply received in the hyosternals. *A. pravus.*

Plastron quite thin; mesosternal occupying an open concavity of the hyosternals; surface everywhere delicately impressed punctate and grooved; intermarginal scuta very long and narrow. *A. agilis.*

Adocus pectoralis, Cope.

Pleurosternum pectorale, Cope, Proc. Ac. Nat. Sci. Phila., 1868, 236; Trans. Amer Philos. Soc. XIV, 1869, 130, Tab. VII. fig. 1.

Indicated by a pair of perfect hyosternal bones from the upper Cretaceous marl bed, near Medford, Burlington Co., N. J.

Adocus beatus, Leidy.

Emys beatus, Leidy. Cretaceous Reptiles. N. Amer. p. 107, Tab. XVIII, fig. 1–3. *Adocus beatus*, Cope, Proc. A. N. S., Phila., 1868, 235. Geological Survey, N. Jersey, App. C, p. 174.

Not uncommon. It is considerably less stout than the preceding. The edges of the posterior lobe of the plastron are thinned out by a submarginal groove. As in other Emydoids there is a marked concavity for each pubic bone. The suture between the hyo- and hyposternal bones is less interlocking than in *A. agilis*, and less fine than in *A. pectoralis.* I have suggested that it may have possessed a slight mobility in life. Its face is longitudinally grooved in the hyposternal, and a corresponding convexity of the face of the hyosternal fits it. In a specimen from Medford, N. J., the posterior lobe is 5 in. 9 lin. long, and 5 in. 8 lin. wide at the marginal notches. Hyosternal of nearly equal thickness, medially 7 lines.

Adocus vyomingensis, Leidy.

Emys vyomingensis, Leidy, Proc. Ac. Nat. Sci. Phila., 1869, p. 66. *Baptemys vyomingensis*, Leidy, loc. cit. 1870, January.

Best known from an almost complete specimen consolidated by the contained mass of mineral. There are three intermarginal bones, of which the middle one is more elongate than the others. There is a weak carina on some of the

posterior vertebral bones. The posterior marginal bones are not revolute. The costal bones are delicately grooved in the length of the carapace. The anterior extremity of the anterior sternal lobe is narrowed, prominent and truncate. Length of the whole animal about two feet.

Found near Ft. Bridger, Wyoming Territory, by Dr. Van Carter.

The genus Baptemys to which this species is referred by Leidy, appears to be the same as Adocus.

Adocus pravus, Leidy.

Emys pravus, Leidy, Proc. Ac. Natl. Sci. Phila., 1656, 303. Cretaceous Rept. U. S., 108. *Adocus pravus*, Cope, Synopsis Batr. Rept. N. Am., 129.

This species is as yet known only from the original specimens, in the collection of the Geological Survey of New Jersey. The plastron is thinner than in the three preceding, and the hyosternals embrace the mesosternum extensively. This distinguishes the species from *A. agilis*, where the mesosternal emargination is much wider than deep. Width of anterior lobe of sternum at epi-hyosternal suture, four inches.

Upper bed of Cretaceous Green sand, New Jersey.

Adocus agilis, Cope.

Geological Survey of New Jersey, App. C., p. 734.

Represented chiefly by an almost complete plastron from the excavations of the West Jersey Marl Company, in the upper bed of the upper Cretaceous Green Sand of New Jersey.

This specimen belonged to an individual of larger size than any heretofore referred to the genus, and one characteristically ornamented by a peculiar sculpture.

The extremities of both lobes are broken off; the margin of the posterior is thinned out, and carries an acuteness of edge to the inguinal notch, where the margin is quite thick. The outline of the caudal scuta is very convex anteriorly; that of the femorals is gently convex towards the front. The suture between the hypo- and xiphisternals is nearly transverse below; on the upper face it sends a process into the hyposternals forwards, which is acuminate; the hyposternals send a marginal process backwards beyond the line of the median suture, which is squarely truncate; its outer edge is the margin of the bone. The impressions of contact of the pubes are well marked; they are strongly incurved, and are not very different from those seen in Cistudo. The bridge of the plastron is preserved, and furnishes attachment for three marginal bones; perhaps fractions of others also. The suture between the abdominal and humeral scuta is convex backwards, and unites with an inner angle of the anterior of the inter-marginal series of the bridge. There are three in the latter series, all longer than broad, but the middle one relatively much narrower than the others, as it is six times longer than wide, with parallel sides. That anterior to it is more hexagonal and wider, presenting an angle inwards for union with the suture between the abdominal and humeral scuta.

About half the mesosternal bone is preserved. It is a transverse diamond with truncate extremities. Its posterior angle is, therefore, very open, but is not rounded. No suture bounding either humeral or gular scuta is visible on it; the anterior angle is broken away. The anterior portion of the ephisternal bone preserved has a regular convex outline, and the sculpture of the inferior surface is a slight imitation of that seen in some species of Trionyx. It is closely shallow-punctate, or like small rain-drop impressions. These are irregularly distributed on the anterior part of the plastron, and on the posterior lobe in obliquely decussating series.

Measurements.

	M. M.		*M. M.*
Width of plastron at bridge,	0.2879	Thickness hyosternum at marginal suture,	0.007
Length between mesosternum and xiphisternum,	0.21	Length abdominal suture,	0.1063
Width posterior lobe at inguinal notch,	0.1835	" femoral "	0.087
" mesosternum,	0.091	" median intermarginal suture,	0.0825
Length "	0.0695	Width " " "	0.015
" hyosternum medially,	0.09	Estimated length plastron,	0.45
Thickness " "	0.012	" " carapace,	0.56

This species, the largest of the genus, is found in the upper green sand bed of the upper Cretaceous of New Jersey. The specimen from which the above description was taken, was found by my friend I. C. Voorhees.

Puppigerus, Cope.

Genus novum Cheloniidarum.

Xiphisternal bones united throughout their length with each other by suture; otherwise as in Chelone.

This genus embraces the Eocene marine turtles of the London clay, and a Miocene species of North America. The difference in the structure of the xiphisternals is very material, especially in view of its significant relationships to the same portion in various other genera of marine turtles.

The Chelone grandævus, Leidy, from the Miocene of Shiloh, N. Jersey, belongs to it. Portions of the sternum display a higher degree of ossification than in Chelone, the hyo- and hyposternal having a very extensive union, greatly restricting the median and lateral fontanelles. This character in the Eocene forms is coincident with the extensive union of xiphisternals, and I do not doubt but that that character belongs to the C. grandævus also. The species of the genus will be:

Puppigerus	grandævus,	Leidy,	Miocene	N. Jersey.	Puppigerus	subcristatus,	Ow. & Bell,	Eocene	England.
"	longiceps,	Ow. & Bell,	Eocene	England.	"	subcarinatus,	"	"	"
"	breviceps,	"	"	"	"	crassicostatus,	"	"	"
"	convexus,	"	"	"	"	? parviscutum,	Cope,	"	N. Jersey.
"	latiscutatus,	"	"	"					

Osteopygis, Cope.

In the cut of a restoration of this genus on page 133, ten costal bones are represented; this is an error, as the true number is nine, the last marginal bone not having any costal bone corresponding to it, as in most other genera, but being united, like the pygal or median, with the large last vertebral bone. Therefore, the suture appearing to bound such a costal posteriorly must be erased from the cut, though it may have existed in a fœtal condition of the genus. The posterior small vertebral must also be erased. The line dividing the large median bone transversely, represents what may be a coössified suture on the specimen, but may not be such.

In this genus the penultimate marginal on each side is known, and exhibits a costal articulation. This marginal is the one omitted from such connection in the Cheloniidæ, Emydidæ, etc. The additional costal in this genus (eight being the number in the order generally) is the anterior, which is articulated to the second instead of the third marginal.

The figure (39) of the restoration of the carapace of Propleura correctly represents ten costal bones, as I determine by a reëxamination of the typical specimen described in the text. This genus and the last I propose to regard as representing a peculiar family of the Amydæ or Cryptodira, to be called the PROPLEURIDÆ. I suspect that Catapleura will also enter it, but whether it has ten ribs or nine I cannot tell. It probably possesses the extra posterior of Propleura, but whether the tenth or anterior is uncertain, as it lacks the pit of the marginal bone. As regards Lytoloma, I can at present give no opinion.

In addition to the characters derived from the carapace, those already adduced (p. 131) as distinguishing this family from the Cheloniidæ, may be added. These are: the humerus with two proximal crests at right angles to each other, diverging from the extremities of the condyles; shaft flattened, slightly curved. Femur with similar trochanteric crests largely developed; shank very slender, gently curved, extremity dilated. Form exactly as in Chelydra.

The peculiar relationships of this group were first pointed out by the writer, in Proceed. Acad. Nat. Sci., 1868, 235; and Proceed. Amer. Phil. Soc., 1869, 16.

PYTHONOMORPHA.

Mosasaurus, Conyb.

Mosasaurus dekayi, Bronn.

A fine specimen of this species was recently exhumed near Mullica Hill, N. Jersey, and submitted to me for examination by the owners. The muzzle is like that figured in profile by Leidy, in Cretaceous Rept. N. America, Pl. XIX, fig. 6; and the quadrate, pterygoids, atlas and suspensorium as described by me in the present work, and in Proc. Boston Soc. N. History, 1869. The teeth are very large, with marked cutting edges and facets. Vertebræ not observed.

Prof. Marsh informs me that the most anterior caudals of M. princeps are sub-pentagonal.

Class III.—AVES.

TOTIPALMATI.

SULA, *Brisson.*

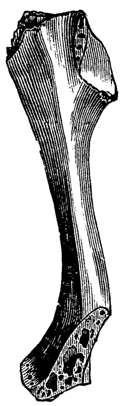
SULA LOXOSTYLA, *Cope.*

Spec. nov. fig. 53.

This species is established on a single coracoid bone which I found at the foot of the Miocene cliffs in Calvert Co., Maryland. The furcular articular surface is broken off, as well as the exterior half of the posterior or sternal articular extremity. The extremity of the scapular surface is also injured. Sufficient of the bone remains to furnish many characteristic peculiarities, and indicate its affinity to the totipalmate family of the Gannetts or Sulidæ.

The bone is stout, and indicates a bird of strong flight. The shaft proper is rather short, and sub-cylindric, with a trihedral tendency. This form, with the expanded distal extremity, indicates its wide distinction from the coracoid of the Gallinaceæ. Its sub-cylindric shaft marks considerable difference from the Lamellirostres and many other aquatic types. Its lack of inner subclavicular ala and foramen, distinguishes the type from Raptores, the majority of Longipennes and many Grallæ. The presence of a marginal groove or rabbett distinguishes it not only from most Psittaci and Insessors, but from many Natatores also. After a study of the large collection of bird skeletons in the Museum of the Academy Natural Sciences, aided by the Oissaux Fossiles of A. Milne Edwards, I find it resembles closely the genus Sula.

Fig. 53.



The glenoid articular face descends to opposite the proximal third of the length; it is transversely concave, and its inferior boundary is raised to separate it from the longitudinal concavity which extends to the head of the bone. A longitudinal angle separates this from the interior part of the inferior face. The anterior extremity is curved upwards and is thinned by a strong rabbett, which follows the convex margin. This margin is slightly obtuse. The outline is abrubtly contracted below the glenoid surface. The inner outline is obtuse, and without trace of the intermuscular ridge, on subclavicular ala. The margin expands inwards to the distal articular extremity, remaining almost equally obtuse. The distal extremity is far less expanded towards the median line of the sternum than in Sula bassana. It is also everted, the outer (inferior) projecting border, being turned out (down) from the line of the shaft. In Sula bassana this marginal rim appears, from Edwards' plate, to be in the plane of the shaft. The articular surface is divided by this rim into a narrow marginal external (inferior) and a very much wider, strongly concave inner portion. The latter is wider at the median end, where its inner (superior) margin is very convex; it then contracts abruptly, leaving the remaining portion only one-half as wide. The very slight prominence of the dividing angulate projecting margin, distinguishes this genus from Sula bassana.

There are three pneumatic foramina of no great size, in a short series commencing just within the head of the bone. I am only able to compare this bone with the figure of the same element of the Sula bassana given by Edwards, as our museum does not possess a skeleton referable to this genus.

As compared with the above, the glenoid articular face descends more posteriorly (lower), and the superior (proximal) margin is more transverse. The shaft viewed from before (below), contracts gradually towards the distal expansion. The same contraction is visible when viewed from the inner side. On the same view we observe that the clavicular articulation is rather more posterior (lower down), and the distal articular marginal edge is far less prominent and acute. The inferior (outer) narrow articular margin is much narrower than in S. *bassana.*

	Inches.
Length to inner distal angle,	2.02
" " posterior basis of scapular articulation,	.78
Width of head last point,	.57
" " glenoid cavity,	.25
" " shaft,	.23
" " distal extremity to middle line of shaft produced,	.43
Thickness distal extremity,	.38

This gannett was somewhat smaller than the S. bassana of our northern coasts, and approached more nearly those of the tropical seas.

Miocene Cliffs of Calvert Co., Maryland. Mus. Nostr.

GRACULUS.

GRACULUS IDAHENSIS, *Marsh*

Sillim. Am. Journ. Sci. Arts, 1870, 216.

Fresh Water Pliocene, Castle Creek, Idaho.

PYGOPODES.

CATARRHACTES, *Briss.*

CATARRHACTES ANTIQUUS, *Marsh.*

Sill. Amer. Journ. Sci. Arts, 1870, 213.

"The left humerus almost identical with the one below mentioned, both in form and size, from Tarboro', Edgecombe Co., N. C., presented by Dr. Booth. Leidy, Pr. A. N. Sci., Phila., 1866, 237, ?? Miocene.

"A right humerus, resembling in its construction that of a Curlew, from a railroad cutting on the banks of the Penobscot River, Bangor, Maine, 47 feet below the surface." Leidy, l. c.. According to Marsh, this belongs to the genus Catarrhactes. Postpliocene.

LAMELLIROSTRES.

LAORNIS, *Marsh.*

LAORNIS EDWARDSIANUS, *Marsh.*

Sill. Amer. Journ. Sci. Arts, 1870, 206.

Middle Green Sand bed, Upper Cretaceous New Jersey.

LONGIPENNES.

PUFFINUS, *Leach.*

PUFFINUS CONRADI, *Marsh.*

Sill. Am. Journ. Sci. Arts, 1870, 212.

Miocene Maryland.

"The lower extremity of a left humerus and a right radius, from a miocene formation of Maryland, presented by T. A. Conrad. The specimens resemble in construction the corresponding parts in a snipe, but are as large as in the Curlew." Leidy, l. c.

GRALLAE.

GRUS, *Linn.*

GRUS HAYDENI, *Marsh.*

Loc. cit. 1870, 214.

"The lower end of a left tibia, from the Pliocene Niobrara River, of Nebraska, discovered by Dr. Hayden, in association with a multitude of mammalian remains. It resembles the corresponding part in a Crane. It is the only

Ornithic fossil among all the vertebrated remains from Nebraska, amounting to several tons in weight, which Dr. L. had detected." (Leidy, Proceedings Academy Nat. Sciences, Phila., p. 237).

PALÆOTRINGA, *Marsh.*

PALÆOTRINGA LITTORALIS, *Marsh.*

L. c., 208.

Cretaceous New Jersey, upper Green Sand.

PALÆOTRINGA VETUS, *Marsh.*

L. c., 209.

Cretaceous New Jersey, ! Lower bed.

"The lower end of a left tibia, from Burlington Co., N. J., described by Dr. Harlan, as the remains of a Snipe, Scolopax (Med. and Phys. Res., p. 280.") Leidy, l. c.

TELMATORNIS, *Marsh.*

TELMATORNIS PRISCUS, *Marsh.*

Loc. cit., p. 210.

Cretaceous New Jersey; upper Green Sand.

TELMATORNIS AFFINIS, *Marsh.*

L. c., 211.

Cretaceous New Jersey; upper Green Sand.

GALLINAE.

MELEAGRIS, *Linn.*

This genus is known from the remains of a single species from the tertiary strata of New Jersey. The portions which furnish its characters are two tibiae, a femur and a coracoid bone, elements which can be fully relied on for the purpose.

Coracoid bone with subtrigonal shaft, and distally but little dilated, the outer half of its inner face distally occupied by a very large pneumatic foramen, which continues for some distance as a tube independent of the general cavity of the bone. Tibia with the pneumatic foramen of the head rudimental. Crest large and prominent, the anterior rising into a prominent spine, the external with thickened decurved margin. Supraligamentous bridge moderately wide, transverse; condyles well separated, the external face of the inner incurved.

The general characters of this genus are intermediate between Crax and Gallus, the Curassows and the common fowls. The great pneumatic foramen of the coracoid is wanting in the typical Gallinae, but characterize the Meleagridae and Southern Hemisphere group of the Cracidae and Megapodiidae. It is larger in the Meleagris, while in Talle-

galla it is smaller; in this species it is immense, though not quite equal in proportions to that observed in Crax alector. The latter species presents, however, a marked pneumatic foramen on the proximal end of the tibia just behind the external crest, which is represented by a very minute one in the present genus. This does not weigh with such importance as to remove the present genus from the same group, for it is equally minute or wanting in Tallegalla lathami, as well as in Gallus and the true Gallinae. The distal extremity of the tibia is more like the Megapodiidae than the Gallus, as well as the proximal, in the lesser proportions of the tuberosity to which the fibula is attached.

The osteology of the Penelopine genera is not accessible to me at present, so that I cannot compare the present one with Oreophasis, Penelope, etc., with which it no doubt has affinity.

MELEAGRIS SUPERBUS, *Cope.*

Established on a nearly perfect right tibia, and imperfect left one, a left femur with the condyles broken off, and a right coracoid bone, with the distal articular extremity imperfect.

The length of the *tibia* will best represent that of the entire bird. It is one-fourth greater than that of a large adult male turkey, and it exceeds that of the same bone of the largest Crax alector in the Museum of the Academy Natural Sciences, by the same amount. It is double the length of the tibia of most of the species of Crax. Its proximal crests are strongly developed. On the articular surface of the head the two anterior concavities are well marked, and the posterior table overhangs the shaft as in Melagris gallopavo, and more than in Crax alector; it is strongly separated from the external tuberosity by a concave notch; from its posterior prominence a keel descends along the shaft separating an external larger from an internal less concave face. The latter is bounded on the inner side by a less prominent ridge. These ridges exist in the turkey, but not in the Crax. The fibular ridge is not prominent below, and is of normal length. The shaft is flattened, least so distally. The internal muscular ridge is well marked, but does not run into a keel on the distal half of the tibia as in Crax alector, but is as in the turkey and Talegalla. The distal tendinous groove is much as in the turkey, and with the transverse bridge, quite as in the turkey, Curassow and Tallegalla. The upper edge of the bridge is thin and easily broken, but it is not so wide as in the single turkey with which I compared it. The intercondyloid groove is open as in the turkey, more so than in Gallus, and with a shallow transverse groove for the articular ligament, which is very faintly traced in Crax and distinct in the turkey. The form of the condyles is more that of the common Fowl than of the turkey and Crax, *i. e.*, the posterior plane is narrow and elevated, not broad and concave. The external faces of the condyles are less concave than in either type, and the inner contracted or incurved, as in the turkey; the outer is not as much flared as in both. The antero-posterior diameter of the head of the tibia enters the total length 5.2 times, being about the proportion observed in the turkey.

The femur, which was found with the tibia and coracoid, and which agree with them in color, mineral character, relative stoutness, appearing in all respects to belong to the same bird, is, nevertheless, relatively shorter than in the genera of Gallinae, with which I have above compared this species. While in Tallegalla, Crax and Gallus, this element is .66 the length of the tibia, it is here .6, and in the M. gallopavo seven-elevenths the same. This disproportion is due to the tibia, which with the femur is more slender than in the genera named. While it is but a small proportion longer than the same bone in the turkey, its superior slenderness is in good proportion to the longer femur. In form it is much as in the genera named. The superior and inferior muscular ridges are more strongly marked than in Crax and Tallegalla, and the trochanteric ridge-like external margin is a little more compressed from above outwards and below inwards, than in the three genera compared. There are two grooves on the articular face of the head, and a short insertion-like ridge just above and in front of it, on the neck.

The *coracoid*, apart from the character of the great pneumatic foramen, is more like that of the turkey than the

Curassow. It is stouter than in the latter; the glenoid cavity or surface is longer than in the latter, entering 4.5 times the length; in the turkey the same; in Crax alector 5.5 times. The inner ridge to which the ligamentous sheet from the clavicle is attached, is strong as in the turkey; the external ridge is also well marked, and the scapular surface is more prominent posteriorly than in the Crax alector. The posterior face is flatter and wider than in the latter, and with several small ridges. The distal articular extremity is gone. The size of the pneumatic foramen is intermediate between that of the turkey and Curassow.

Measurements.	*M.*
Length of tibia,	0.245
" " anterior crest,	0.032
" " fibular ridge,	0.051
Diameter of head, antero-posterior,	0.039
" " transverse, with ext. crest,	0.045
" " " without do.,	0.03
" " shortest (diagonal),	0.0245
" of condyles, transverse,	0.017
" " " antero-posterior (outer),	0.0173
" " shaft, transverse (at middle),	0.0125
" " " shorter "	0.0105
Length femur, actual,	0.116
" " restored,	0.146
Diameter of shaft below neck (transverse),	0.022
" " " at middle "	0.0135
Length coracoid, actual,	0.112
" " restored,	0.115
" head from glenoid surface,	0.021
Diameter, transverse, at middle,	0.013
" " " end foramen,	0.022
" antero-posterior, at middle,	0.012

In recapitulation it may be noted, that the characters in which this species differs from the common turkey are, the longer tibia and femur, the greater slenderness of the same, and the larger pneumatic foramen of the coracoid bone.

The specimens on which it is based were discovered some three or four feet in the Cretaceous marl of the lower bed, by my friend, Dr. C. C. Thompson. Their mineral condition indicates, however, very plainly, that they are not Cretaceous fossils but tertiary, and I have no doubt they were either dragged into a burrow which entered the Cretaceous bed, which is in the locality in question near the surface, by a carnivorous animal, or really fell into a cavity from the thin layer of Tertiary, probably postpliocene, sand which lies immediately above it. The remains were accompanied by those of a Mammal, which Dr. Thompson assured me he took out with them.

Postpliocene of Monmouth Co., New Jersey.

ON FOOT IMPRESSIONS OF EXTINCT BATRACHIA AND REPTILIA.

As is well known, those species pertaining to the classes treated of in the preceding essay, which lived in or near water, have left impressions of their feet on the ancient mud-flats, and lake and ocean shores. Commencing with those which have been discovered in the lowest rocks, we have three species from the Carboniferous formation. The oldest is represented by two series of impresions, obtained at different times, in the red shales which pertain to the upper division of the subcarboniferous (Lesley), at a point seven hundred feet below its upper surface. The next in order, is indicated by a few tracks from the shales of the coal measures, from a point 300 feet above the conglomerate (Gabb), and therefore, 6450 feet from the top of the coal measures. The latest of these tracks, which were found still higher, came from a point 800 feet below the surface of the coal.

The oldest of these have been found by Messrs. Lea, Rogers and Leidy, near to Pottsville, Schuylkill Co., Penna. The first named naturalist referred them to "a four-footed, air-breathing animal, allied to the Saurians," under the name of Sauropus primævus. At that time the important differences between the Reptilia and Batrachia were not known; had they been, disputes as to the Reptilian or other affinities of these creatures would have been unnecessary. As no remains certainly referable to Reptiles have been found below the Permian rocks, it is not reasonable to suppose that the tracks are Reptilian, as Agassiz has insisted. On the other hand, there can be no doubt that these creatures were air-breathers, as Lea has pointed out. To palæontologists of the present time, there can be no doubt that the Sauropus was a large Batrachian; which position is entirely confirmed by the form of the tracks themselves.

The tracks which come next in order, are from 2031 feet higher, and were discovered by Wm. M. Gabb, on the valley of the Little Schuylkill River, about ¾ mile from the town of Tamaqua, Schuylkill Co., Penna. They are of peculiar form, and much more like those of the Reptiles than either of the others here mentioned.

They are on the surface of a thin irregular shale about sixteen inches in length. There are many impressions on this surface, one of the most abundant of which consists of three or four parallel grooves. Most of the others are intermediate. The prominent impression is that of the hind foot of an animal of medium size. There are five toes of remarkably slender form, a sole broader than long, and a narrow and rather long tarsus projecting behind. The lengths of the toes are, commencing with the shortest, 1—2—5—3—4, but the extremity of the second extends a little further than that of the fifth. There is no impression certainly referable to claws, though there is a weak impression at the ends of the first and second digits. There has evidently been no palmar membrane. The sole of the metatarsus is transverse, and is separted by a ridge (in the impression; a groove in the foot,) from the tarsal track, showing that the animal may have been usually not plantigrade, but rather as in existing Salamanders. The heel is about as long as the width of the metacarpus, subacuminate, and most impressed and contracted on the side next the shortest toe.

Measurements.	*In.*	*Lin.*
Total length,	2	4
Length to sole from heel,		9.
" of sole to fourth toe,		5.5
" " fourth toe,	1	23
Width of sole,		9
" " heel,		4
" between extremities toes,	1	5

Fig. 54.

The impression of the corresponding foot has been obliterated by subsequent marks. At a distance of four inches behind the heel a track of four toes similar to that already described, would appear to pertain to the same animal; they are imperfect, and the heel is broken off with the rock.

A single impression remains, whose position, form and size would appear appropriate to the present species. It belongs, like the hind foot, to the right side, the short toes being on the inner side. Its position is a little (8 lines) behind the posterior track, on the inner side, and 2 in. 2.5 lines in advance of the imperfect track mentioned. It consists of the impressions of four toes, whose extremities project in the following order: 4—1—2—3. Within the inner (first) toe, there is a short pit, which may be a rudimental 5th toe, and just behind it, an oval depression of the carpus. As in the hind foot, the digits are remarkably slender.

	Lines.
Length of track,	9.5
Expanse of toes,	5.5.

Some of the trisulcate impressions are in the line of progress of the animal, and may have been produced by its tail.

The broad metatarsus of this animal is Batrachian, as is the apparent lack of claws, while the remarkably slender digits constitute a Lacertian feature. The most singular character, the prolonged, narrow tarsus, is not found in any

Tailed Batrachian of the present period, but is a known peculiarity of the Anura. In this respect, then, the present creature would appear to be most nearly allied to that Order. The slender toes are also much more consistent with that type than with the Urodela; nevertheless, the remains of the Stegocephalous form Sauropleura digitata from the coal measures of Ohio, indicate similar digits.

Though no species of the Stegocephali appears to be known which presents the elongate tarsus, some of them (Pelion) present Anurous characters in the cranium,* and therefore, the present peculiarity need not be unexpected. From the fact also, that no Anura have been discovered in older strata than Tertiary, while Stegocephali are eminently characteristic of the Carboniferous, it is safe to suppose that the present is one of the forms of the same type.

The animal which left the impressions of its feet in the coal measures of Westmoreland Co., Penn., is the third and highest in order of position. It was discovered by Dr. King, of Greensburg, and stated by him to consist of twenty-three consecutive steps of a single individual. The step marks present the short thick digits of many tailed Batrachia, and no doubt represent another genus of the Stegocephali. It was called Thenaropus heterodactylus by King, and was of considerable size.†

Ascending in the scale of strata, the Triassic Rocks of Pennsylvania, New Jersey and the Connecticut Valley present us with a great number of tracks. Small tracks have been discovered by Wheatley in the lower part of the section which he has been so fortunate as to observe in the tunnel at Phœnixville, on the Schuylkill. They come from the "black shales," about 190 feet below the top of the series. A posterior foot track is wide, with five short toes, the inner and outer very short; the order, 5—1—4—2—3, is that of their lengths, the longest being the third. The sole is wider than long. It was no doubt made by a Batrachian. Dr. I. Lea has described other tracks from the same position and locality, under the name of Chelichnus wymanianus.‡

Dr. Chas. Hitchcock has found tridactylous bird-like tracks in the red shales of the same series near to Easton, Penna., and similar ichnolites have been discovered by J. H. Smock, of the New Jersey State Geological Survey, at a point on the Delaware River above Trenton.§ They compare closely with some of those of the Connecticut Valley. The most important series of tracks of any extinct fauna, is that brought to light by Hitchcock and Deane, and published by the former in the Ichnology of Massachusetts, and the supplement to the same. With the corrections introduced in the latter, the number of species of Vertebrata represented is ninety-eight, which are referred to 42 genera. These are distributed under the following heads:

	Genera.	*Species.*		*Genera.*	*Species.*
Fishes,	1	2	Ornithoid Lizards or Batrachians,	7	14
Chelonians,	5	9	Narrow-toed Birds,	4	13
Batrachia,	10	15	Thick-toed Birds,	2	16
Lacertilians,	11	20	Marsupialoid Mammalia,	3	9

The identification of species and genera from their tracks is in a degree practicable, when the family or other higher group is known. This latter degree of exactitude is, however, impossible, except for the very highest rank of divisions. Of the classes to which the above species are referred, we fully expect to see the Fishes, Batrachians, and Rhynchocephalians‖ represented, as their remains occur in strata of like age elsewhere. Tortoises have not yet been found below the Jurassic, yet as the first forms are of no doubtful type, they may be looked for in the Trias. As to the two groups of Ornithoid lizards and thick-toed birds, the greatest probability attaches to their being Dinosauria and to some extent Thecodontia. The belief in the presence of Mammals must be left for the discovery of their remains. Their existence is, of course, not beyond the limits of possibility, yet palæontologists will not find anything absolutely inconsistent with the reptilian type in the examples of supposed Mammalia brought forward by Dr. Hitchcock. Birds would seem to be more likely to be found, and if they be their representatives, one would think, must have been the first of their class. We, however, reserve acquiescence to the theory of their existence until it be proven that they were not bird-like Dinosauria.

The sizes of the tracks vary from those appropriate to the small recent reptiles of the same latitude, to forms of medium size like Clepsysaurus, and to those which can only find their counterparts in the gigantic Hadrosauri and Lælapes of the Cretaceous period. To such animals Hitchcock has applied the name of Anomœpus, Brontozoum, and Otozoum.

*As Wyman has pointed out.

†See Dana's Manual of Geology, p. 51.

‡Proc. Ac. Nat. Sci., Phila., 1856, 78.

§See Geol. Survey of N. J., by Cook, p. 174.

‖ Huxley's supposed Triassic Lacertilia appear to be all Rhynchocephalia.

CONCLUSION.

Synopsis of Species with their Stratigraphical Positions.

	Sub-carb.	Carbonif.	Trias.	Jurass.	Cretac.	Eocene.	Miocene.	Pliocene.	Postplioc.	Page.
BATRACHIA.										
Foot prints,	*	*	*							240
Amphibamus grandiceps, Cope,		*								8
Pelion lyellii, Wyman,		*								9
Hylonomus wymanii, Dawson,		*								9
Do. aciedentatus, Dawson,		*								9
Do. lyellii, Dawson,		*								9
Pariostegus myops, Cope,			*							10
Dendrerpeton acadianum, Owen,		*								13
Do. owenii, Dawson,		*								13
Do. obtusum, Cope,		*								12
Hylerpeton dawsonii, Owen,		*								13
Brachydectes newberryi, Cope,		*								14
Sauropleura digitata, Cope,		*								16
Oestocephalus pectinatus, Cope,		*								20
Do. remex, Cope,		*								17
Molgophis macrurus, Cope,		*								21
Colosteus crassiscutatus, Cope,		*								23
Do. foveatus, Cope,		*								24
Do. marshii, Cope,		*								24
Dictyocephalus elegans, Leidy,			*							25
Eupelor durus, Cope,			*							25
Baphetes planiceps, Owen,		*								25
Do. minor, Dawson,		*								
REPTILIA.										
Eosaurus acadianus, Marsh,		*								30
Ichthyosaurus grandis, Leidy,			*							29
Elasmosaurus platyurus, Cope,					*					47
Do. orientalis, Cope,					*					55
Cimoliasaurus magnus, Leidy,					*					43
Do. ?vetustus, Leidy,					*					42
Do. grandis, Leidy,					*					43
Polycotylus latipinnis, Cope,					*					36
Ischyrosaurus antiquus, Leidy,					*					39
Plesiosaurus lockwoodii, Cope,					*					40
Piratosaurus plicatus, Leidy,					*					56
Belodon carolinensis, Emmons,			*							59
Do. priscus, Leidy,			*							59
Do. Leaii, Emmons,			*							59
Do. lepturus, Cope,			*							59
Mosasaurus maximus, Cope,					*					189
Do. dekayi, Bronn,					*					193
Do. fulciatus, Cope,					*					194
Do. oarthrus, Cope,					*					196
Do. copeanus, Marsh,					*					198
Do. missuriensis, Harlan,					*					195
Do. brumbyi, Gibbes,					*					198
Do. minor, Gibbes,					*					198
Do. crassidens, Marsh,					*					198
Do. depressus, Cope,					*					196
Platecarpus tympaniticus, Cope,					*					200
Liodon lævis, Owen,					*					205
Do. proriger, Cope,					*					202
Do. validus, Cope,					*					207
Do. mitchillii, Dekay,					*					205
Do. congrops, Cope,					*					206
Baptosaurus platyspondylus, Marsh,					*					209
Do. fraternus, Marsh,					*					210
Clidastes iguanavus, Cope,					*					220
Do. intermedius, Leidy,					*					221
Do. propython, Cope,					*					221
Holcodus acutidens, Gibbes,					*					210

Synopsis of Species with their Stratigraphical Positions—Continued.

	Subcarb.	Carbonif.	Trias.	Jurass.	Cretac.	Eocene.	Miocene.	Pliocene.	Postplioc.	Page.
Pliogonodon priscus, Leidy,					?*		?*			
Polygonodon vetus, Leidy,					*					210
Do. rectus, Emmons,							*			211
Stylemys nebrascensis, Leidy,							*			124
Do. niobrarensis, Leidy,							*			124
Do. culbertsonii, Leidy,							*			124
Cistudo eurypygia, Cope,									*	124
Emys obscurus, Leidy,				*						124
Do. petrolei, Leidy,									*	128
Do. turgidus, Cope,					*					127
Do. petrosus, Cope,					*					126
Do. firmus, Leidy,					*					126
Do. stevensonii, Leidy,					*					
Adocus beatus, Leidy,					*					129—233
Do. agilis, Cope,					*					234
Do. pravus, Leidy,					*					129—233
Do. vyomingensis, Leidy,					*					233
Do. pectoralis, Cope,					*					130—233
Compsemys victus, Leidy,				*						124
Osteopygis emarginatus, Cope,					*					136
Do. platylomus, Cope,					*					135—235
Do. chelydrinus, Cope,					*					138
Propleura sopita, Leidy,					*					140
Catapleura repanda, Cope,					*					143
Lytoloma jeanesii, Cope,					*					145
Do. angusta, Cope,					*					145
Euclastes platyops, Cope,					*					149
Peritresius ornatus, Leidy,					*					150
Trionyx foveatus, Leidy				*						152
Do. halophilus, Cope,					*					151
Do. pennatus, Cope,					*					152
Do. priscus, Leidy,					*		*			153
Do. buiei, Cope,							*			153
Do. lima, Cope,							?*			153
Do. guttatus, Leidy,						*				152
Puppigerus parviscutum, Cope,							*			155—235
Do. grandævus, Leidy,						*				153—235
Lembonax polemicus, Cope,					*					168
Bothremys cookii, Leidy,					*					157
Taphrosphys molops, Cope,					*					159
Do. sulcatus, Leidy,					*					164
Do. longinuchus, Cope,					*					162
Do. leslianus, Cope,					*					166
Do. strenuus, Cope,					*					166-B
Do. nodosus, Cope,						*				167
Palæophis littoralis, Cope,						*				227
Do. halidanus, Cope,						*				227
Do. grandis, Marsh,										228
Crotalus sp.,									*	
Bottosaurus harlani, Meyer,					*					65
Do. tuberculatus, Cope,					*					230
? Crocodilus humilis, Leidy,										82
Thecachampsa squankensis, Marsh,				*			*			65
Do. fastigiata, Leidy,							*			65
Do. sicaria, Cope,							*			63
Do. antiqua, Leidy,							*			64
Do. sericodon, Cope,							*			64
Thoracosaurus neocaesariensis, Dekay,					*					79
Holops obscurus, Leidy,					*					75
Do. cordatus, Cope,					*					73
Do. tenebrosus, Leidy,					*					78
Do. brevispinus, Cope,					*					69
Do. glyptodon, Cope,					*					74-231
Do. basitruncatus, Owen,										231

Synopsis of Species with their Stratigraphical Positions—Continued.

	Subcarb.	Carbonif.	Trias.	Jurass.	Cretac.	Eocene.	Miocene.	Pliocene.	Postplioc.	Page.
Hypsosaurus rogersi, Owen,					*					80
Do. fraterculus, Cope,					*					82
Rhabdopelix longispinis,* Cope,			*							172
Palæoscincus costatus, Leidy,				*						99
Hadrosaurus foulkei, Leidy,					*					98
Do. mirabilis, Leidy,†				*						98
Do. ? occidentalis, Leidy,					?*					98
Do. minor, Marsh,					*					122–J
Astrodon johnstoni, Leidy,					*					99
Troodon formosus, Leidy,				*						120
Megadactylus polyzelus, Hitchcock,			*							122–A
Bathygnathus borealis, Leidy,			*							119
Clepsysaurus pennsylvanicus, Lea,			*							122–A
Aublysodon horridus, Leidy,				*						120
Lælaps aquilunguis, Cope,					*					100
Do. macropus, Cope,					*					118
Coelosaurus antiquus, Leidy,					*					119
Ornithotarsus immanis, Cope,					*					120

RECAPITULATION.

Number of Species.

BATRACHIA.	
Xenorhachia,	1
Microsauria,	14
Ganocephala,	3
Labyrinthodontia,	4
REPTILIA.	
Ichthyopterygia,	2
Sauropterygia,	8
Thecodontia,	4
Testudinata,	42
Pythonomorpha,	22
Ophidia,	3
Crocodilia,	16
?———	1
Dinosauria,	15
AVES,	11
Total,	146

Distribution in Time.

	Sub-carboniferous.	Carboniferous.	Triassic.	Jurassic.	Cretaceous.	Eocene.	Miocene.	Pliocene.	Postpliocene.
BATRACHIA.									
Xenorhachia,		1							
Microsauria,		13	1						
Ganocephala,		3							
Labyrinthodontia,		2	2						
REPTILIA.									
Ichthyopterygia,		?1	1						
Sauropterygia,					8				
Thecodontia,			4						
Pythonomorpha,					22				
Testudinata,				3	27	2	6	1	3
Ophidia,						2			1
Crocodilia,				1	11	1	3		
?———			1*						
Dinosauria,			3	4	8				
AVES,					5		2	2	2

*This form is quite as likely to prove Rhynchocephalian as Pterosaurian. †The supposed Jurassic strata of the Judith River may not belong to that period.

COMPARATIVE OBSERVATIONS.

The study of the early extinct vertebrata of this country possesses three points of interest, to which the attention of students has been drawn. First: the period at which given types of life have appeared on the earth; second: whether such types present abrupt beginning and close, or exhibit a connection with others by intervening and only partly subordinate forms; third: whether the periods of existence of given types were synchronous in different regions of the earth.

With reference to the second point, it may be said, that, although investigations in the field in question bring to light forms combining peculiarities once supposed to exist only in distinct types, the primary divisions as herein defined have not yet been found to be connected by forms not referable to any of them. If we suppose that such have existed, it is only by the analogy of forms discovered to be intermediate on a lower grade of characters.

The period of commencement of the Reptilian Orders has been generally believed to be that of the Permian. No reptile has been discovered in and below the Coal Measures in the old world, and nothing has been found in the new to invalidate this general statement. Batrachia have left their tracks in the Subcarboniferous; below this they are not known; their remains first appear in the Carboniferous. Birds first appear in the Cretaceous, though they have been chiefly found in Eocene and Miocene strata.

With regard to the relative abundance of these types in the two continents, it may be observed, that with present knowledge they appear to be nearly similarly developed, with the following exceptions: The American formations are very poor in Ichthyopterygia and Pterosauria, orders greatly developed in Europe; while they contain abundant remains of Pythonomorpha, which is represented in European beds by but few species. The subject is, however, in its infancy.

With respect to the synchronism of the Reptilian faunæ here alluded to, the knowledge of the subject is not sufficient to furnish basis for an opinion, but I have elsewhere attempted to show that similar faunæ were quite as likely to prove successional, and successional faunæ synchronous, as the reverse. (See Origin of Genera.)

As to the relations of times of appearance in the continents of Europe and North America, we know too few species to be able to make more than a comparison which time may invalidate. Of the periods of predominance of types a little more may be said. Thus, both continents alike present a majority of the smaller Stegocephalous Batrachia during Carboniferous time, and of the larger Labyrinthodonts during Triassic time.

Our only Ichthyopterygia (not reckoning Eosaurus) appear in supposed Triassic beds: those of the old world do not occur before the Jurassic (one is noted from the German Trias). The old world Sauropterygia greatly predominate in the Jurassic, though a few

occur in the Cretaceous. In North America they predominate in the Cretaceous. Thecodontia are Triassic in both continents; and the Pythonomorpha are alike Cretaceous. The serpents are in neither region older than Eocene.

Among Testudinata, Trionyx is first Cretaceous in America, first Eocene in Europe. Chelonoid Emydidæ, also Cretaceous here, are first Jurassic in Europe. In the latter period the order has so far been best represented; those beds are rare in our country, but if present, it could scarcely be more abundantly productive of them than is our Cretaceous.

Among the Crocodilia, the amphicœlian division is especially Jurassic, not occurring in the Cretaceous; our only genus was abundant in the latter period. The procoeli are characteristic of the tertiary in Europe, a very few being noted as from the upper Cretaceous. Here their chief abundance is in the Cretaceous, from which they extend to the present time.

The Dinosauria are characteristic of the upper Cretaceous period in North America, and of the Jurassic to a less degree. In Europe they characterize the Jurassic, and are rare in the Cretaceous. Thus, of corresponding genera Lælaps is upper Cretaceous, Megalosaurus and Poecilopleurum, Jurassic. Hadrosaurus, upper Cretaceous and Jurassic; Iguanodon, Jurassic and lower Cretaceous. Astrodon and Hypsibema middle Cretaceous; Hylæosaurus, Jurassic. Further, we have evidence of many Dinosauria in the Trias., by their foot-tracks and the remains of Megadactylus, Clepsysaurus and Bathygnathus, which are nearly related to the genera of the Trias of England and Germany.

STRATIGRAPHICAL OBSERVATIONS.

I. The Cretaceous of New Jersey.

A full review of the vertebrate species from the Cretaceous of New Jersey, results in the conviction that but few of them belong to types which are necessarily marine, while many of them are the representatives of the genera which are at the present day purely fresh-water. Taking them seriatim, it is obvious that the six Dinosauria are terrestrial, and if at all, but occasional swimmers. The eight Crocodiles have only fresh-water representatives at the present day. The shortness of the limbs of these reptiles is not adapted to stemming the waves of the open ocean or an undefended coast, for any long period; and this observation will apply to all marine vertebrates with separated digits whose life is spent in the water, and who rely on their limbs for progression, unless their bulk be such as to render them independent of the waves, or they are furnished with wings. Thus, the marine turtles possess long oar-like limbs, while those of brackish and fresh waters have short paddles of far less power. The limbs of the twenty-four species found in New Jersey, are of the latter character, and all their modern representatives in-

habit rivers and lakes. Trionyx, a well-known river type, is represented by three species; none are known to be marine.

There remain the orders Pythonomorpha and Sauropterygia, none of whose members exist at the present day. These were probably truly marine, as well as associated with the estuary types already enumerated.

It may be asserted that there is no systematic evidence to show that the ancient representatives of our fresh-water forms were not marine, and to this a partial assent may be given. We may look to some other sources of evidence in explanation of the question.

The most westward division of the Cretaceous, embracing the bed No. 1, of Meek and Hayden, which contains abundant leaves, etc., of terrestrial plants, may have been more entirely fresh than the others, as I have suggested, Proceed. Acad. Natl. Sci., 1868, 157.*

The second, or Ripley clay, has produced few vertebrate remains, the most important, the Hadrosarus foulkei, a terrestrial animal. The molluses are largely marine.

The third series, embracing the lower green-sand bed, contains more numerous vertebrates, as Mosasaurus, Thoracosaurus, etc., but, as my friend, Jno. Smock, of the State Survey, has observed, almost no tortoises. To this, one exception occurs in the Trionyx halophilus, Cope, which is from near the Delaware and Chesapeake Canal, in Delaware, from the lower bed. The species which are only known from these two clays and marls, are as follows:

From the Clays of No. I.
Plesiosaurus lockwoodii.
Ornithotarsus immanis.
Hadrosaurus foulkei.

From the Clays and Marl of the first bed.
Elasmosaurus orientalis.
Clidastes iguanavus.
Mosasaurus fulciatus.
Mosasaurus maximus.
Mosasaurus dekayi.
Trionyx halophilus.
Trionyx priscus.
Emys sp.
Beryx insculptus (*fish*).

From the Rotten Limestone of Alabama.
Mosasaurus brumbyi.
Liodon congrops.
Clidastes propython.
Clidastes intermedius.

The fourth series, embracing the second green-sand bed, contains the greatest number of vertebrate species, distributed as follows:

Sauropterygia, 2; Crocodilia, 10; Dinosauria, 4; Testudinata, 22; Pythonomorpha, 6.

The remains of these are all found in the lower division of the green-sand bed, defined

* T. A. Conrad and Prof. Newberry, believe these beds to be Triassic; I have stated it as my belief, that some of them are Jurassic. I am confirmed in this opinion by the discovery of a species of Asteracanthus, by Dr. G. J. Fisher, of Sing-Sing, a genus known only in the Jurassics of the old world.

by Cook in the Geological Survey of New Jersey as the Chocolate-stratum. This bed differs from the pure green-sand above it, in its containing a much larger proportion of clay and sand, indications of shallower water. Near its middle is the great bed of Ostrea vesicularis, also an indication of estuary enclosure. While bones are abundant throughout, they are especially so near its upper surface. I suppose it, therefore, to have been the slowly subsiding bottom of an area not far removed from shore. The termination of the Chocolate bed, and commencement of the stratum of pure green-sand, indicates perhaps a more rapid or sudden submergence to the greater depth, appropriate to the life of the Globigerinæ, in whose empty shells the green-sand grains are supposed to have been formed. That towards the close of this period of deposit shallower water may have covered the area, is suggested by the great bed of Ostrea vesicularis at that horizon. Between it and the chocolate, the remains of Reptilia are comparatively rare.

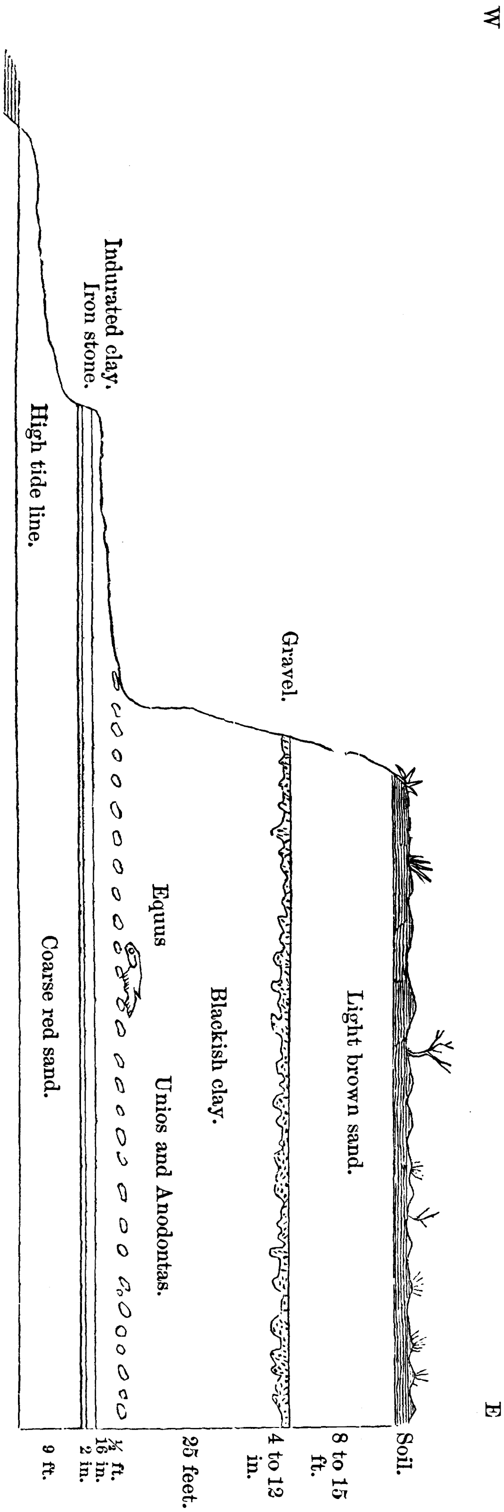
From the above, I am much disposed to conclude that the clay and mixed green-sand marls of our upper Cretaceous were deposited in a series of estuaries, whose direction followed the lines of the Appalachian axis, *i. e.*, northeast and southwest, and which were protected by shore lines to the seaward. Such a shore line formed of an anticlinal of Eozoic rocks, separated an estuary from the Miocene ocean in North Carolina. Its crest can be seen where exposed by the denuding action of the Tar, Cape Fear and other rivers and streams.

II. The Fresh-water Clays of the Pea Shore.

This deposit, which I discovered to be truly fresh-water in its origin, by the observation of numerous species of Unio and Anodonta near its base, has been regarded by Rogers and all others who have examined it up to the present time, as a member of Meek and Hayden's No. 1, and as lying conformably beneath the upper Cretaceous strata to the southward and eastward. The most important part of the deposit consists of a heavy black clay which is used for making brick, which rests on a bed of hard laminated clay, with a thin layer of iron-stone between. The clay bed at one place examined, is 25 feet in thickness, and at from one to three feet from its bottom occurs a bed of fresh-water mussels. These are Unios and Anodontas of six species, all of them as pointed out to him by Dr. Lea, hitherto undescribed. The beds are from the top of the clay down, conformable, and have a dip of about 25° to the southeast. The upper surface of the clay is worn into holes, which are filled by the material of a bed of coarse gravel of little depth, which covers the whole. Above this is a bed of fine sand varying from 6 to 15 feet in thickness to the soil.

The following section of the exposure at Pea Shore, will give the best idea of its character.

Fig. 55.



The regularity of the beds as exposed for some distance along the line of the Camden and Amboy R. R., and their S. E. dip, apparently similar to that of the Cretaceous beds above them, has seemed to confirm the supposition of authors as to their horizon. I believe, however, that they really belong to a much later age than the bed No. 1, and are really of a Pliocene period, and older than the stratified drift. Two reasons have a strong bearing on the question. A large part of the cranium of a horse—Equus fraternus of Leidy—was found by the workmen just above the Unio bed, and twenty feet below the top of the clay, evidently in place. The underlying bed of coarse red sand, is in all apparent respects identical with the material of a stratum which underlies the soil over the country 5 and 6 miles to the eastward of Pea Shore, *e. g.*, the town of Haddonfield, which rests unconformably on the Ripley division of the Cretaceous. It does not exist on the surface, so far as I could ascertain from an examination on one line, between these points. It may be the same bed.

That this bed is synchronous with our Postpliocene, is doubtful, from the marked difference presented by the Unios, when compared with those now existing. The Helices of the Postpliocene are identical with the living species, viz: H. major, H. tridentata, H. dentifera, etc., are associated with Tapirus, Dicotyles, Equus, etc., in cave deposits. The Unionidæ, Lea remarks, have the heavy teeth of one type of the genus, with the light thin shells of another type, and are all distinct from the living. An older age than Postpliocene is, therefore, indicated.

EXPLANATION OF WOOD CUTS.

Fig. 1, p. 12.—Cranium of *Dendrerpeton obtusum*, Cope, natural size; from Prof. Newberry's collection.

Fig. 2, p. 19.—*Oestocephalus remex*, Cope, caudal vertebræ, natural size; from Prof. Newberry's coll.

Fig. 3, p. 31.—*Nothosaurus* probably *andriani*, Münst., from above; fig. 4, same from below; much reduced; from the German Trias.

Fig. 5, p. 32.—*Mecistops intermedius*, Graves, one-eighth natural size, profile; fig. 6, same, from above; Qu = quadrate bone. From Mus. Academy Nat. Sciences; supposed to be from the Orinoco.

Fig. 7, p. 41.—Femur of *Cimoliasaurus magnus*, from New Jersey, about one-fourth natural size; fig. 8, same, distal extremity. Fig. 9, posterior dorsal vertebra of *Cimoliasaurus magnus*, same individual as the last.

Fig. 10.—Posterior dorsal *Elasmosaurus platyurus*, a little less than one-fourth the natural size.

Fig. 11.—*Elasmosaurus platyurus*, scapular arch inferior elements, restored; the portions not preserved, shaded. One-sixth natural size.

Fig. 12.—Pelvic arch, inferior elements of the same, one-sixth natural size; the shaded portions restored.

Fig. 13.—The ilium of the same, lateral view; fig. 14, distal extremity of the same.

Fig. 15.—Cervical and anterior dorsal vertebræ of *Cimoliasaurus magnus*, (Mus. Academy Nat. Sciences) compared with,

Fig. 16,—Posterior cervical and anterior dorsal vertebræ of *Elasmosaurus platyurus;* the transverse processes of the former incurved by pressure.

Fig. 16 A, p. 64.—Section near apex of crown of tooth of *Thecachampsa antiqua*, Leidy; B, do. of *Thecachampsa sicaria*, Cope.

Fig. 18, p. 73.—Outlines of the cups of the fourth dorsal vertebræ of *Holops cordatus* and *H. obscurus;* the external unshaded representing the former, the internal shaded, the latter.

Figs. 19–20, p. 77.—Inferior and lateral views of a muzzle of *Holops basitruncatus*, Owen, (See Appendix to Reptilia) one-third natural size.

Figs. 21–4, p. 83.—*Perosuchus fuscus*, Cope, living sp. from Darien; fig. 21 profile, 22 superior face of the cranium; the acute processes near the left canine tooth are an error of the artist; 23 the fore, and 24 the hind foot.

Figs. 25–6, p. 85.—Lateral and superior views of the cranium of *Osteolaemus tretraspes*, Cope, recent species from West Africa.

Fig. 27, p. 92.—Proximal portion of scapula of *Hadrosaurus foulkei*, from New Jersey; upper right hand figure, the extremity with glenoid cavity; lower figure, interior view.

Fig. 28, p. 93.—The unidentified bone, from Monmouth Co., New Jersey.

Fig. 29, p. 95.—Restoration of pelvis of *Hadrosaurus foulkei*, dotted portions wanting; *a*, posterior or acetabular view of proximal end of pubis. One-tenth natural size; *b*, inner view of ischium of *Clepsysaurus pennsylvanicus*, Lea, one-third natural size; from the types in Mus. Philada. Acad. Nat. Sci.

Fig. 30, p. 103.—Caudal vertebræ of *Laelaps aquilunguis*, one-eighth natural size; shaded portions wanting in original; neural spines not completed.

Figs. 31 to 34, pages 118–119.—*Laelaps macropus*, hind limb; 31, proximal extremity of tibia; 32, proximal portion of metatarsal; 32a, proximal extremity of same, natural size; 33, distal portion of external metatarsus, postero-external view; 34, antero-external view of same.

Figs. 35–7, p. 122.—*Ornithotarsus immanis*, Cope, extremities of tibia and fibula; 35 from anterior, 36 from posterior, 37 from extremital view: in all of these the suture defining the astragalo-calcaneum is too distinct; 36a, fractured extremity, showing medullary cavity with cancelli.

Fig. 38, p. 133.—Restoration of carapace of *Osteopygis platylomus:* the last costal suture on each side, and the last small vertebral bone sutures should be erased, as they are not visible in the mature specimen. See Appendix to Reptilia. The anterior vertebral bone also, is not known. One-sixth natural size.

Fig. 39, p. 134.—*Osteopygis platylomus* plastron, restored; shaded portions not found.

Fig. 39, p. 139.—*Propleura sopita*, carapace restored, one-sixth natural size. First vertebral not known.

Fig. 40, p. 154.—Proximal extremity of humerus of *Puppigerus grandaevus*.

EXPLANATION OF WOOD CUTS—Continued.

INDEX.

(FOR INDEX OF SPECIES, SEE PAGE 243.)

ERRATA AND ADDENDA.

Page 17, lines 14 and 15—9. The bones here described as coracoid and limb bones are, it now appears to me, more likely to belong to the hyoid apparatus, as they somewhat resemble corresponding bones of Necturus; the genus Oestocephalus was therefore probably branchiferous.

" 21, l. 5, for "be found" read, belong to one of them.

" 22, l. 1, for "**GNOCEPHALA**" read **GANOCEPHALA.**

" 37, l. 17, for "caudals," read cervicals.

" 44, l. 19, omit the word "form."

" 44, under Elasmosaurus, Leidy having attempted to show that *Elasmosaurus* is the same as Discosaurus Leidy, which should also include Cimoliasaurus L., I have controverted the positions assumed, in Silliman's Am. Journ. Sci. Arts, 1870, 139–268.

" 48, l. 13, for "anterior" read posterior.

" 108, l. 16. The discovery of the outer or shortest metatarsus confirms this measurment; its length is sixteen inches.

" 129, l. 9. For "strongly emarginate," read "narrowed to an obtuse extremity." After this see appendix, p. 232, where a third species, A. AJILIS, Cope, is added, and a paper in Proceedings A. Phil. Soc., 1870 (November), where A. SYNTHETICUS, Cope, is described, with two new genera ZYGORAMMA, Cope, and HOMOROPHUS. These are with ADOCUS erected into the family of *Adocidæ*. The new species are Z. STRIATULA and H. INSUETUS, Cope.

" 129. l. 21, omit Pleurosternum, Bell.

" 130, l. 8. for "Pleurosternum" read Adocus.

" 146, 22, the large specimen here described belongs to the O. platylomus.

" 137, l.l. 4—11—13—16, for "emarginatus" four times, read, platylomus.

" 143, line 21, for "22⅔" read 2⅔.

" 151, l. 7, for "widens" read wide as.

" 169, l. 1, for PTEROSAURIA read (?) RHYNCHOCEPHALIA.

" 180, l. 15, omit all after "A structure somewhat resembling," &c.

" 198, l. 1. The vertebræ described as pertaining to Mosasaurus brumbyi belong to another reptile, probably a Liodon, which I have called L. perlatus.

" 208, l. 30. Add here three species described in Proceed. Boston, Society Nat. History, Dec., 1870, LIODON ICTERICUS, Cope, and LIODON MUDGEI, Cope, from the Cretaceous chalk of Kansas, and L. DYSPELOR, Cope, from New Mexico.

" 227, l. 9. Add here two new species described with the above; CLIDASTES CINERIARUM, Cope, and C. ANTIVALIDUS, Cope, the latter figure in this volume, Pl. V. fig. 5.

" 233, l. 17, for "lines" read times; for "mesosterna" read mesosternal.

" 233, l. 41. Adocus vyomingensis does not belong to this genus, but to an allied form, Baptemys of Leidy and is probably of Tertiary age. Adocus proves to have an intergular scutum and be the type of a family combining Cryptodire and Pleurodire characters.

" 239. The bird described as *Meleagris superbus*, I am informed by Prof. O. C. Marsh, is the same as that exhibited by him at a meeting of the Academy Natural Sciences, March 8th, 1870, (Proceedings p. 11) and named *Meleagris altus*, Marsh. Of this fact I had no knowledge until after the above form had been printed off, and now rely exclusively on Prof. Marsh's statement for the identification, as no description accompanies the name, and I have not seen the types. As Prof. Marsh has priority of discovery and determination, it is entirely proper that the species should bear his name, *M. altus*.

" 242, line 6 from bottom, for "acquiescence to" read acquiescence in.

NOTE.—The present work was issued up to page 105 in August, 1869, and up to page 235 in April, 1870. The third part is issued in December, 1870.

EXPLANATION OF THE PLATES.

PLATE I.

Figs. 1–12. Vertebræ and limb bones of *Polycotylus latipinnis*, Cope, from Kansas; (see p. 34) one half the natural size.

1. Profile of separated neural arch of a dorsal vertebra from the left side.

1a. Posterior view of same, showing deep compressed basis of the elevated diapophysis.

2. Dorsal vertebra: 2a, the same from below.

3. Another dorsal vertebra posterior view; 3a, the same from the left side.

4. Another dorsal, from a position less median than the last, anterior view; 4a, the same from the left side; 4b, the same, inferior view.

5. An anterior caudal vertebra from behind, exhibiting the surfaces for chevron bones; 5a, the same from below.

6. A more posterior caudal, obliquely crushed, showing proximal end of one limb of a chevron bone in place.

7. Two coössified cervical vertebræ from below; 7a, the same from the side, the neural arches being lost.

8. Proximal end of supposed ilium, external view (p. 37). 9, the undetermined bone.

10. Tibia; 11, tarsal bone.

12. Metatarsal and phalanges.

13. Portion of cranium of *Holops brevispinis*, Cope, from above; 75 of the natural size. From Tinton Falls, Monmouth Co., N. J. In the cabinet of Rutger's College, N. J.

14–15. *Hypsibema laticauda*, Cope, from Sampson Co., N. Ca., one half the natural size. In the state cabinet at Raleigh, N. Ca.

14. Right external metatarsal.

15. A caudal vertebra; 15a, inferior; 15b, posterior views.

16. *Taphrosphys nodosus*, Cope, one-half natural size, from Hornerstown, Monmouth Co., N. Jersey. Portions of two costal bones.

PLATE II.

Figs. 1–9. *Elasmosaurus platyurus*, Cope, from near Fort Wallace, Kansas. Fig. 1, one? forty-fifth natural size; figs. 2–10, one-third the natural size.

Fig. 1. Restoration of the skeleton of *Elasmosaurus platyurus*, Cope. The limbs, and the cranium behind the end of the muzzle, are entirely hypothetical.

Fig. 2. Three caudal vertebræ, probably eleventh to fourteenth, seen from the left side; 2*a*, the same seen from below.

Fig. 3. An anterior median dorsal vertebra, seen from the articular extremity; 3a, the same from beneath.

Fig. 3b. A median dorsal with subquadrate section, from beneath.

Fig. 4. Anterior dorsal of the same, from the extremity; 4*a*, from below.

Fig. 5. Two median cervicals, from the side; *a*, from below.

Fig. 6. Two distal cervicals, with (?) parapophysis preserved; *a*, from below; *b*, the articular extremity, the (?) parapophysis of the left side broken.

Fig. 7. The connate atlas and axis.

Fig. 8. The extremity of the muzzle, from above; 8*a*, do. from the side, displaying the broken teeth; 8*b*, the symphysis, from below.

Fig. 9. The alveolus and fang of a mandibular tooth.

Fig. 10. Sacro-caudal vertebra of *Elasmosaurus orientalis*, Cope, from near Swedesboro, Gloucester Co., N. J., inferior view; 10a, from the side. Both one-third natural size.

PLATE III.

Four anterior dorsal vertebræ of *Elasmosaurus platyurus*, Cope, of one-half the natural size, belonging to the individual figured on Plate II. Seen from the right side.

PLATE IV.

Figs. 1–3. *Holops obscurus*, from Burlington Co , N. J., one individual.

Fig. 1. Cervical, dorsal and isolated lumbar vertebræ a little more than three-fifths natural size.

Fig. 2. Femur of same, one-half natural size.

Fig. 3. Humerus of same, one-half natural size.

Fig. 4. Vertebral column of a young *Holops brevispinis*, Cope, from Burlington Co., N. J., one-half natural size, seen from below.

Fig. 5. Anterior dorsal vertebra of adult *Holops brevispinis*, Cope, one-half natural size, from the side; fig. 5a, same from the front.

Fig. 6. Humerus of the same, one-half natural size.

Fig. 7. Posterior-median dorsal of *Holops caudatus*, Cope, from Barnesboro, one-half natural size.

Fig. 8–9. Vertebræ of *Holops basitruncatus*, Ow.,one-half natural size (marked erroneously on the plate *Bottosaurus harlani*).

Fig. 8. Cervical vertebra of the same, from below; fig. 9, lumbar of the same, anterior; and 9a, inferior views.

Fig. 10. Femur of *Hyposaurus rogersii*, Ow., from the inside; one-half natural size.

Fig. 11. Humerus of the same individual as fig. 10. Both from Barnesboro, N. J., and in the cabinet of the State Geological survey at Rutger's College.

PLATE V.

Fig. 1. Anterior dorsal vertebra of *Palæophis littoralis*, Cope, from the right side; 1*a*, from the front; 1*b*, from below. From specimens belonging to the Geological survey of N. Jersey.

Fig. 2. *Palæophis halidanus*, Cope, anterior dorsal vertebra, from below; 2*a*, same from the front; both this species and the last, of natural size. The latter in Prof. Marsh's collection, Yale College.

Fig. 3. Dorsal vertebra of *Clidastes iguanavus*, one-half natural size, from the side; the neural spine is broken away; 3*a*, anterior view; 3*b*, view from above; 3*c*, from below. This vertebra is in Prof. Marsh's collection at Yale College, Conn.

Fig. 4. Posterior lumbar vertebra, from Barnesboro, supposed by me formerly to belong to *Mosasaurus depressus*. It is not probably that species, but more likely *Liodon validus*, but of this I cannot assure myself. 4*a*, from the side; 4*b*, from below. One-half natural size.

Fig. 5. Dorsal vertebra referred in the text to *Liodon lævis*, but probably a *Clidastes* to be called *C. antivalidus*, Cope (Proceed. Bost. Soc. N. Hist., 1870, December), seen from the side; 5*a*, from below; 5*b*, from behind. One-half natural size.

Fig. 6. Fragment of ramus mandibuli of *Thecachampsa sicaria*, Cope, lateral view; 6*a*, superior view; one-half the natural size. 6*b*, apex of the crown of one of the teeth, natural size. Specimens in possession of Philip T. Tyson, Baltimore, Maryland, from the mouth of the Patuxent River, Md.

Fig. 7. Crown of the tooth of *Thecachampsa sericodon* Cope, from Charles County, Md. Natural size.

Fig. 8. Tooth of the same species, from Shiloh, Cumberland County, N. J. Natural size.

PLATE VI.

Cranium of *Euclastes platyops* Cope. From above. A little smaller than natural size. From Hurffville, N. J.

PLATE VII.

Fig. 1. Hyosternal bones of *Adocus pectoralis*. From Medford, N. J. One-half natural size.

Fig. 2. *Catapleura repanda*. One-half natural size. *a*, nuchal, with first to middle of fourth marginal bones of the right side; *b*, sixth marginal; *c*, eighth and part of ninth right marginals.

Fig. 3. *Osteopygis emarginatus*. One-half natural size. *a*, nuchal with first left marginal, and parts of both first costals; *b*, fifth left marginal; *c*, tenth left marginal; *d*, anterior vertebral. From Barnesboro, N. J.

Fig. 4. *Propleura sopita*. One-half natural size. *a*, nuchal, first marginal and first costal, broken; *b*, third and fourth left marginals; *c*, fifth left marginal; *d*, eleventh left marginal bone; *e*, humerus, anterior view; *f*, do., lateral view; *g*, femur, anterior, and *h*, lateral views.

Fig. 5. Two costal bones of the same individual, one-half natural size.

Fig. 6. Carpal bone of another individual (from Harrisonville, N. J.). Natural size.

Fig. 7. Proximal phalanges of fore-foot of the last individual. A lateral view.

Fig. 8. ?Tenth right marginal of *Osteopygis chelydrinus*. Natural size.

Fig. 9. *Euclastes platyops*. Profile of cranium. One-half natural size. (The artist has depressed the occipital profile too much.)

Fig. 10. Metatarsal of *Stylemys nebrascensis*. Natural size.

Fig. 11. Left pubis of the same. Natural size.

Fig. 12. Right humerus of the same individual. Natural size.

Fig. 13. *Trionyx pennatus*. Costal bone; distal extremity. One-half natural size.

Fig, 14. *Trionyx lima*. Costal bone; distal extremity. One-half natural size.

Fig. 15. *Trionyx halophilus*. Vertebral and proximal portion of costal bone. One-half natural size. From Summit Bridge, Delaware.

Fig. 16. Nuchal, and first and second marginal bones of *Taptrosphys molops*. From Barnesboro. One-third natural size.

PLATE VIII.

Fig. 1. Femur of *Laelaps aquilunguis*, Cope. External view. One-fourth natural size. 1 *a*, same, anterior view.

Fig. 2. Caudal vertebra of the same, lateral view. One-half natural size. 2 *a*, same, anterior view.

Fig. 3. Anterior caudal vertebra of the same, from above. One-half natural size.

PLATE IX.

Fig. 1. Tibia of *Laelaps aquilunguis*, the inner side. 1 *a*, the same, anterior view. Size one-fourth nature. 1 *c*, distal extremity of the tibia.

Fig. 2. Fibula of the same, seen from the tibial or inner face.

Fig. 3. Astragalus of the same, anterior view. One-third natural size. 3 *a*, external view. 3 *b*, inner extremity. 3 *c*, ascending apophysis.

Fig. 4. Distal caudal vertebra of the same. One-half natural size.

PLATE X.

Fig. 1. Penultimate phalange of *Laelaps aquilunguis*, lateral view. Natural size.

Fig. 2. Ungueal phalange of the same, lateral view. Natural size.

Fig. 3. Humerus of *Laelaps aquilinguis*, external view. One-half natural size. 3 *a*, same, posterior view.

Fig. 4. Ischiadic bone of the same, the inner side. One-third natural size.

Fig. 5. Fragment of right ramus of the mandible of the same, with functional and successional teeth. One-half the natural size.

Fig. 6. Crown of a successional tooth of the same jaw (seen in Fig. 5 behind the second tooth). Natural size. (The artist has represented the denticulations finer than in nature.)

Fig. 7. Beak of the Eocene fish *Coelorhynchus ornatus*, Leidy. From near Petersburg, Va. From the collection of John S. Haines, Germantown, Pa. The bones of the *Laelaps* figured in Plates VIII., IX. and X., are those of the type specimen from Barnesboro, N. J,

PLATE XI.

Fig. 1. Mandible of *Lytoloma angusta*, Cope. One-half natural size. Lateral view. 1 *a*, same, from above. 1 *b*, median lateral marginal bone, lateral view.

Fig. 2. Posterior part of carapace of *Taphrosphys sulcatus*, Leidy. One-fourth natural size. The inner or inferior view. (The artist has omitted the distal part of the iliac scar on the left middle costal bone of the plate.

Fig. 3. Cervical vertebra of *Hyposaurus rogersii* from behind. Natural size.

Fig. 4. *Laelaps aquilunguis*. Extremity of non-anchylosed sacral vertebra of type specimen. One-third natural size.

Fig. 5. Lateral view of a second sacral vertebra of same. 5 *a*, superior aspect of the same.

Fig. 6. *Mosasaurus depressus*, os quadratum, distal extremity and part posterior hook broken off; external view; one-half natural size; from type specimen from Burlington Co., N. J.

Fig. 7. *Mosasaurus maximus*, os quadratum with the posterior proximal hook broken off; one-third natural size; external view. Museum Rutger's College.

Fig. 8. Suspensorium of *Mosasaurus* perhaps *M. dekayi*, from above; 5–11th, natural size; 8*a*, posterior part of the squamosal bone of the same specimen, in natural relation, except its removal to a short distance to show the entering angle of the opisthotic.

Fig. 9. Long bone (?) of the pelvis or limbs, of *Rhabdopelix longispinis*, from the Trias. On the same block of sand stone is the section of a vertebra; natural size.

PLATE XII.

Figs. 1–21. *Clidastes propython*, Cope, from Uniontown, Alabama; one-half the natural size.

Fig. 1. Cranium from above.

Fig. 2. The same from below.

Fig. 3. Profile of same, with under jaw.

Fig. 4. Left quadrate bone external face; natural size.

Fig. 5. Axis, anterior view, showing odontoid process; natural size.

Flg. 6. The same, posterior view.

Fig. 7. Three cervical vertebræ from below; the 3d, 4th, and 5th.

Fig. 8. The 9th, 10th, and 11th vertebræ (dorsals), from above, displaying glenoid cavity and adjacent parts of coracoid bone, adherent on the inferior face.

Fig. 9. Anterior view of the 9th vertebra (from cranium).

Fig. 10. Inferior view of 18th, 19th, and 20th vertebræ.

Fig. 11. Anterior caudal vertebræ, from right side.

Fig. 12. Posterior caudals.

Fig. 13. Anterior view of a caudal vertebra from a position in advance of those represented in fig. 11.

Fig. 14. More distal caudals.

Fig. 15. Terminal caudals.

Fig. 16. Coracoid and part of scapula of left side.

Fig. 17. Humerus, Ulna, Radius, and first row of carpal bones. (The latter were dislocated by the artist and not accurately replaced by him; thus the interosseous margins of the outer and middle carpals should be continuous, &c) Natural size.

Fig. 18. Distal extremity of humerus.

Fig. 19. Proximal extremity of humerus.

Fig. 20. Right humerus anterior (exterior) face.

Fig. 21. Carpal bone natural size.

Figs. 22 to 24. *Liodon proriger*, Cope, from the cretaceous beds of Kansas. Museum of Comparative Zoology, Cambridge, Mass.

Fig. 22. Muzzle from above, anterior to the middle of the prefrontal bone; one-fourth natural size

Fig. 23, Same in profile.

Fig. 24. First maxillary tooth natural size.

PLATE XIII.

Fig. 1—9. *Megadactylus polyzelus*, Hitchcock, natural size. From the museum of Amherst college.

Fig. 1. Left Femur, posterior view; 1a, inferior extremity from behind; 1b, superior extremity antero-exteriorly; 1c, inferior extremity from before; 1d, same, extremital view.

Fig. 2. Fibula; proximal end at top, distal end at bottom of plate, middle of shaft lost.

Fig. 3. Tibia, proximal end external view; 3a, same, extremital view.

Fig. 4. Fibula and proximal part of foot, from the outer side; 4a, cuboid bone; 4b, metatarsal.

Fig. 5. A dorso-lumbar vertebral centrum from below; fig. 6a, proximal caudal from above showing the lower margin of the latteral foramen.

Fig. 7. Two caudal vertebræ, the anterior injured, and with a portion of a chevron bone.

Fig. 8. A distal caudal vertebra, side view.

Fig. 9. Right anterior foot.

Fig. 10. (Erroneously marked 4 by the artist; see upper right hand corner of plate) connate ischiadic bones from below; 10a (4a), lateral view; 10b (4b), distal extremity.

Fig. 11. (Below 2; number omitted in plate) probably pubes, side view.

PLATE XIV.

Figs. 1 to 4. Bones of Belodon lepturus, Cope, from Phœnixville, Pennsylvania, from the private collection of Charles M. Wheatley, A. M. One-third the natural size.

1. Median dorsal vertebra anterior view; 1a, right side of the same.

2. Diapophysis of dorsal with tubercular and capitular surfaces, a little more posterior in position.

Fig. 3, 4, and 5. Three dorsal vertebræ in close connexion in the matrix but not consecutive in the skeleton. Fig. 3, a dorsal near the position of fig. 2 from side; 3a, from the anterior extremity. Fig 4, a vertebra from a position posterior to 3, from the right side; 4a, from in front. Fig. 5, centrum without processes, of a vertebra from near 3.

Fig. 6. Diapophysis with capitular and tubercular faces, of a dorsal vertebra from between 3 and 4.

Fig. 7. The last dorso-lumbar vertebra, with slender diapophysis and united capitular and tubercular faces; 7a, the same from behind, showing the lateral facets for the sacral diapophyses, and fragments of two or three dermal bones covering the neural spine; 7b, the same vertebra from below.

Fig. 8. Caudal vertebra from the right side; 8a, the same, posterior view.

Fig. 9. A more posterior caudal vertebra from the right side; 9a, the same from below.

Fig. 10. A chevron bone posterior view.

Fig. 11. A number of ribs with a fragment of a vertebra above them.

Fig. 12. Fragment of the pelvis; *a*, the ilium; *b*, the ischium.

Fig. 13. The left femur; 13a, proximal extremity; 13b, distal extremity.

Fig. 14. Fibula, extremity broken off.

Figs. 15—25. *Belodon priscus*, Cope. Montgomery Co., North Carolina. Museum Academy Natural Sciences, Philadelphia; one-third natural size.

Fig. 15. Angle of the mandible, showing the truncate posterior margin, and inferior suture of the articular bone; 15a, superior view of the same showing the transverse cotylus for the quadrate behind and margin of large dental foramen within.

Fig. 16. Extremity of same mandible, right side of symphysis; 16a, same inferior view; 16b, fragment of frontal bone with part of orbit.

Fig. 17. Anterior dorsal or posterior cervical of same, left side; 17a, same from behind.

Fig. 18. Portions of two dorsal vertebræ, the separate neural spines, one resting obliquely on the arch of the other.

Fig. 19. A caudal vertebra, left side; 19a, the same, inferior view.

Fig. 20. A dermal bone; 20a, a profile.

Fig. 21. (?) Ulna, proximal extremity; 21a, end view.

Fig. 22. Astragalus.

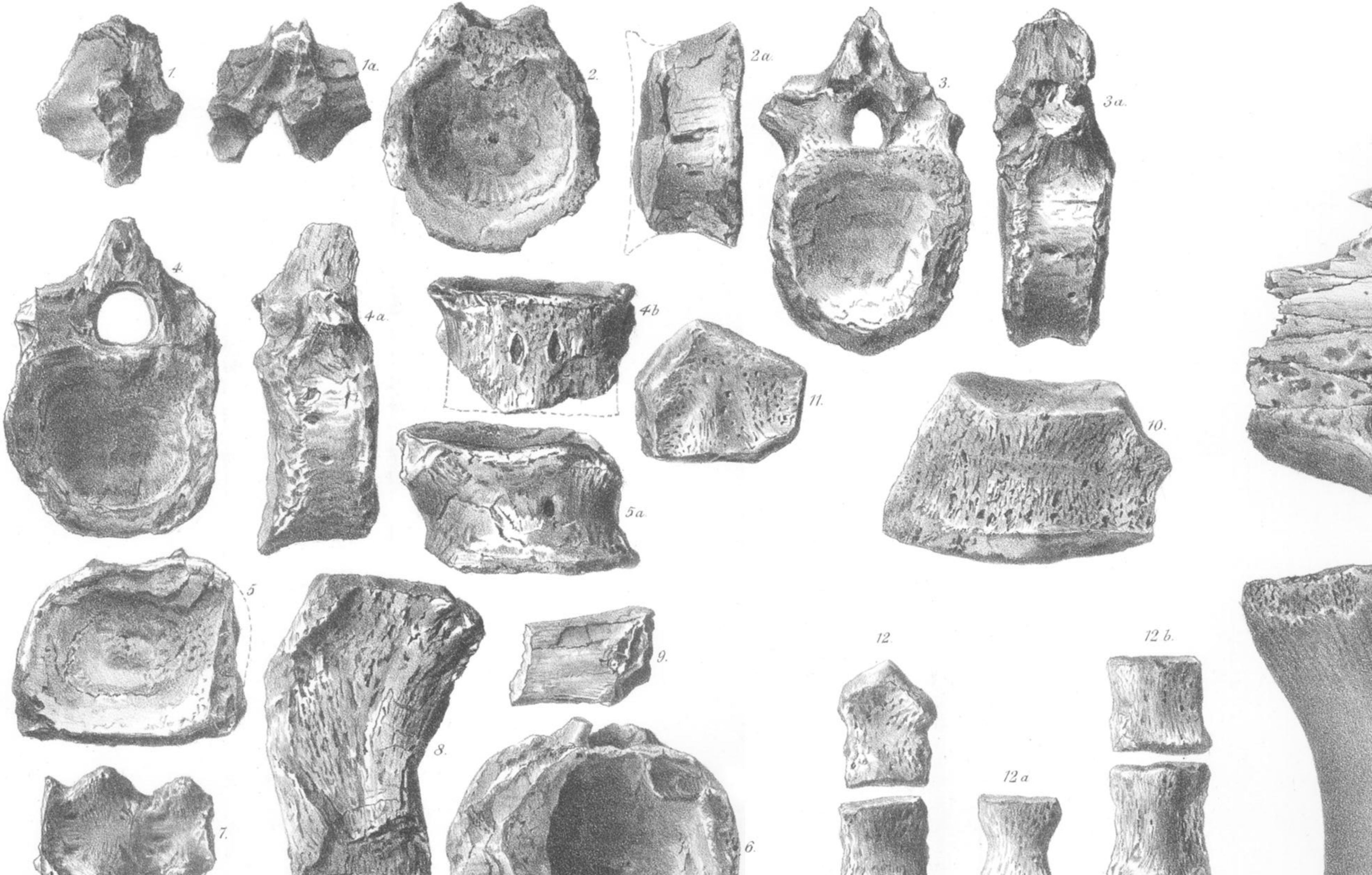
Fig. 23. Cuboid bone.

Fig. 24. Metatarsal proximal extremity.

Fig. 25 Four marginal bones of the right side of the carapace of Lytoloma jeanesii from Hornerstown, discovered by Jno. G. Meirs; a, the first, b, the second marginals, the latter without distal end; c, perhaps the fifth, nearly entire; d, eighth or ninth, proximal extremity wanting.

Figs. 1-12 Polycotylus latipinnis.
Figs. 14.15. Hypsibema crassicauda.

Fig. 13. Holops brevispinis.
Fig. 16. Taphrosphys nodosus.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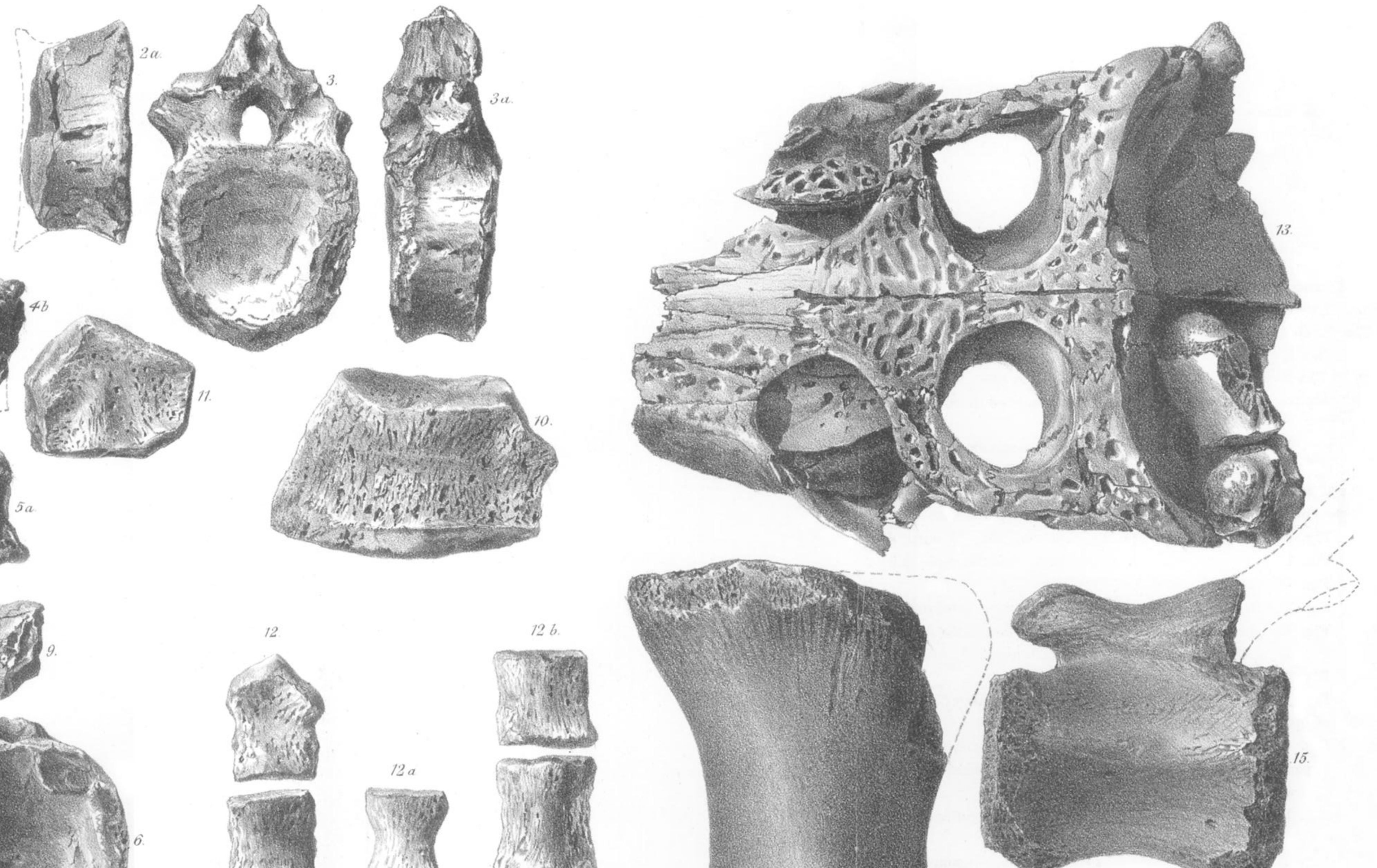
gs. 1-12 *Polycotylus latipinnis.*
gs. 14. 15. *Hypsibema crassicauda.*

Fig. 13. *Holops brevispinis.*
Fig. 16. *Taphrosphys nodosus.*

T. Sinclair's lith. Phila.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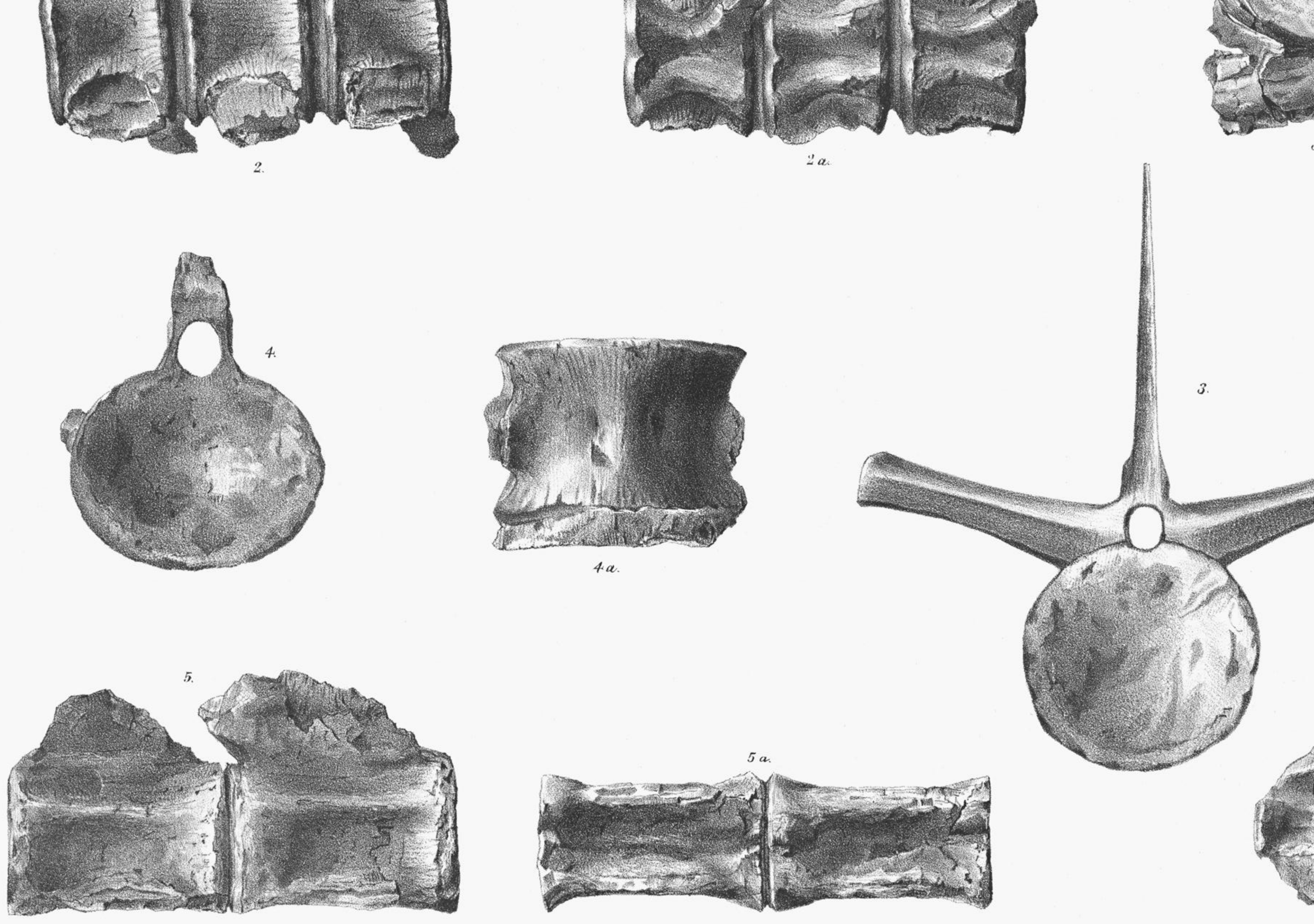
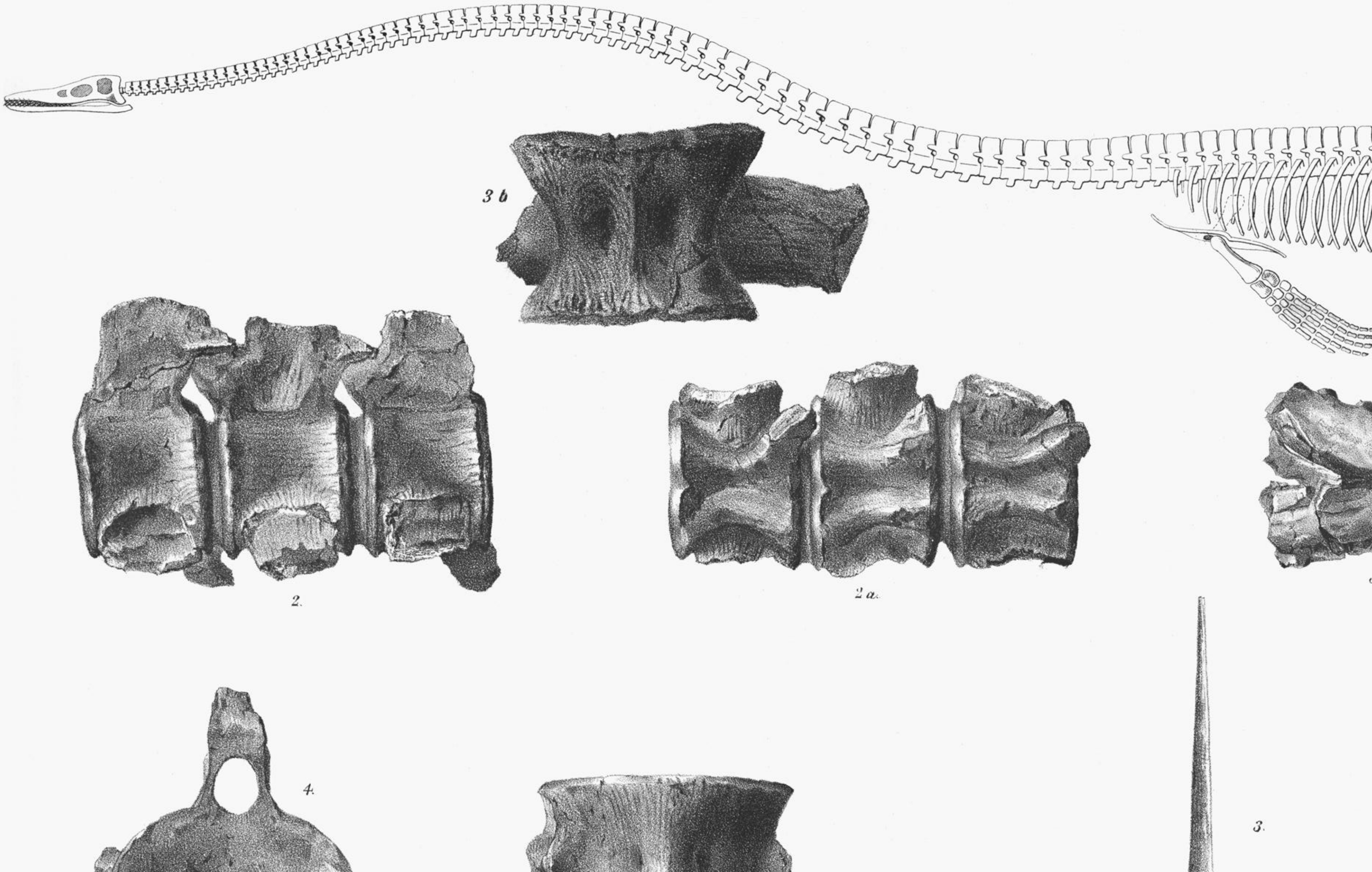
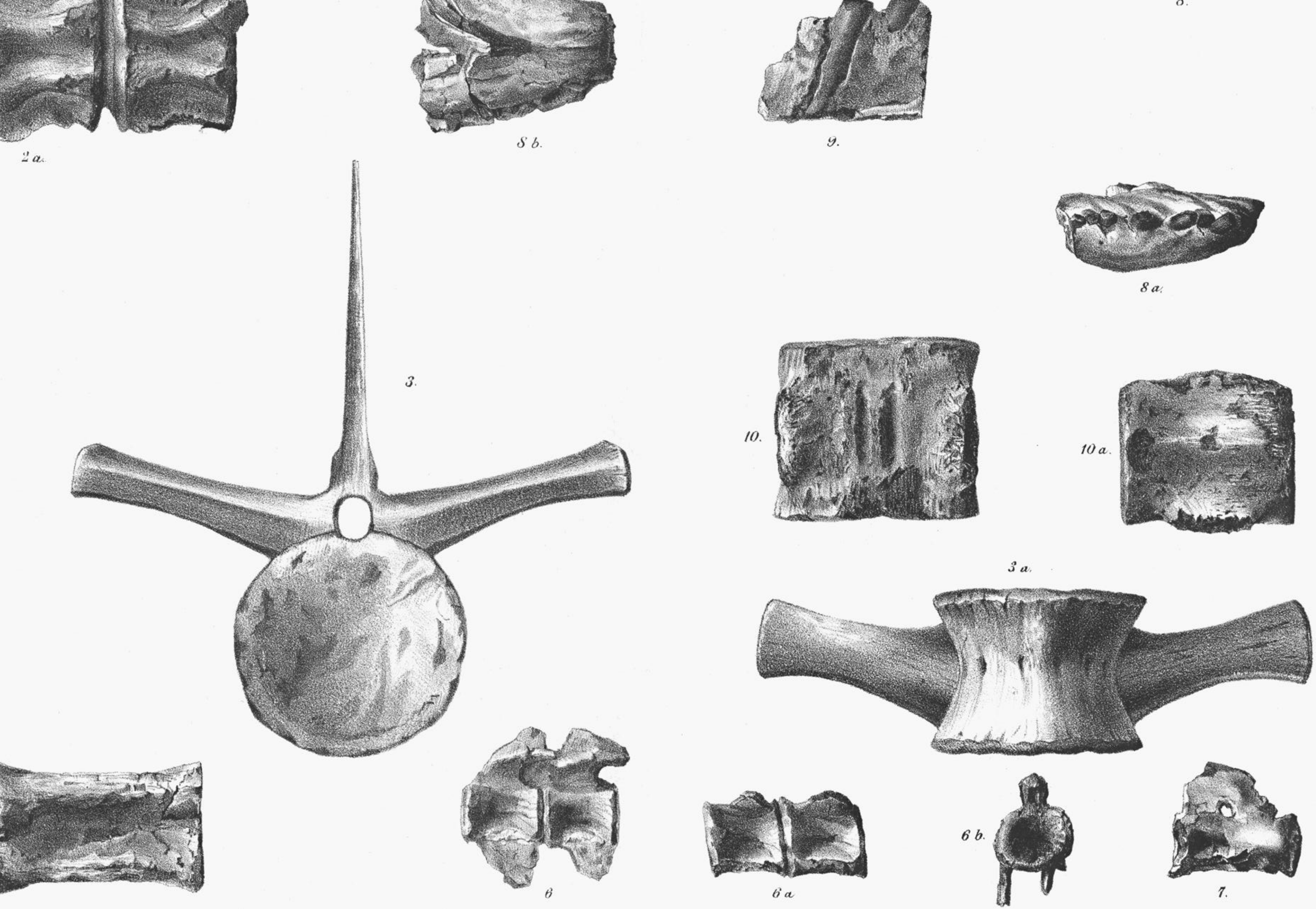


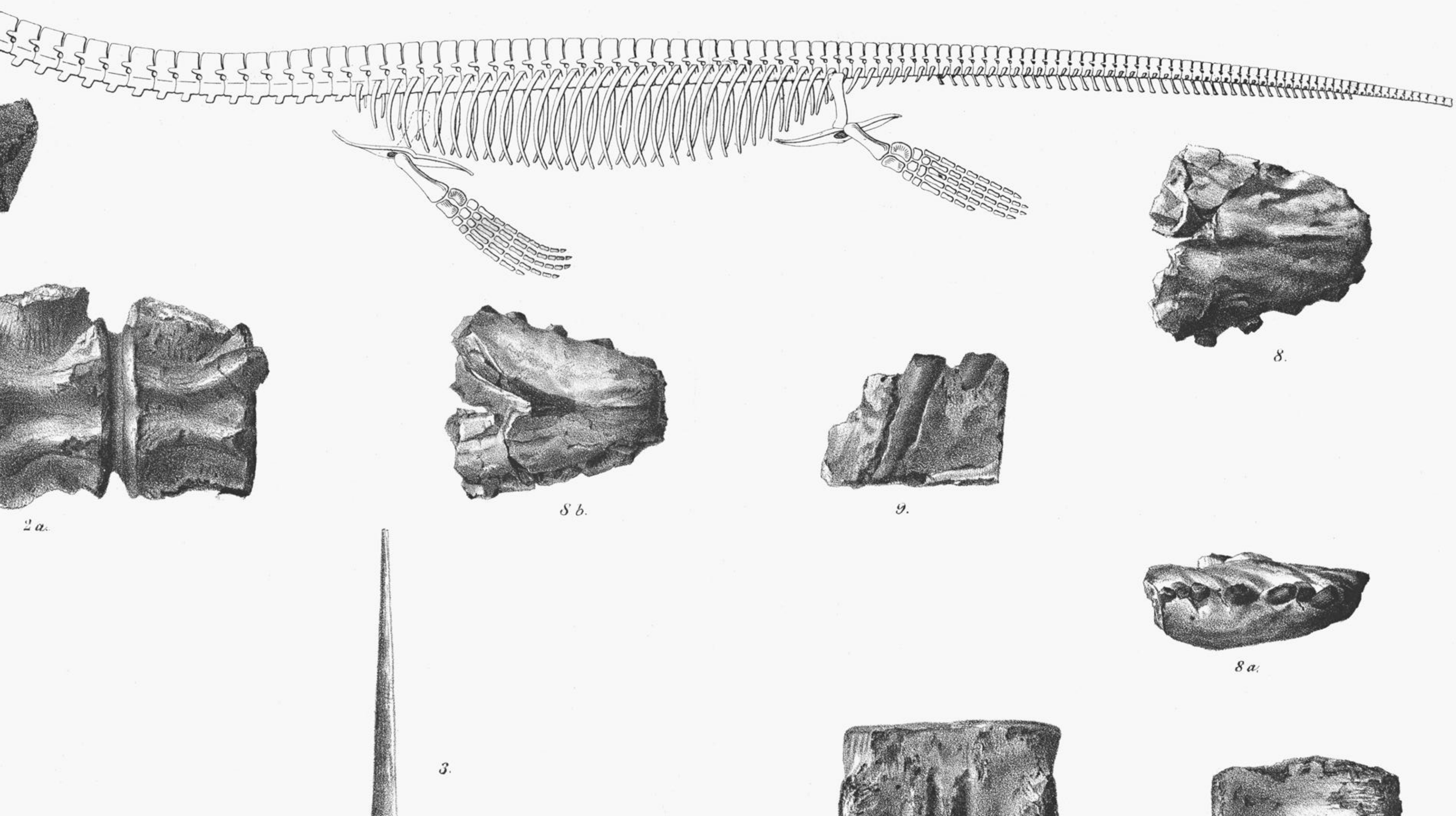
Figs. 1–9. Elasmosaurus platyurus.   Fig. 10. E. Orien

Cope on Fossil Batrachia &c.





gs. 1–9. *Elasmosaurus platyurus.* *Fig. 10. E. Orientalis.*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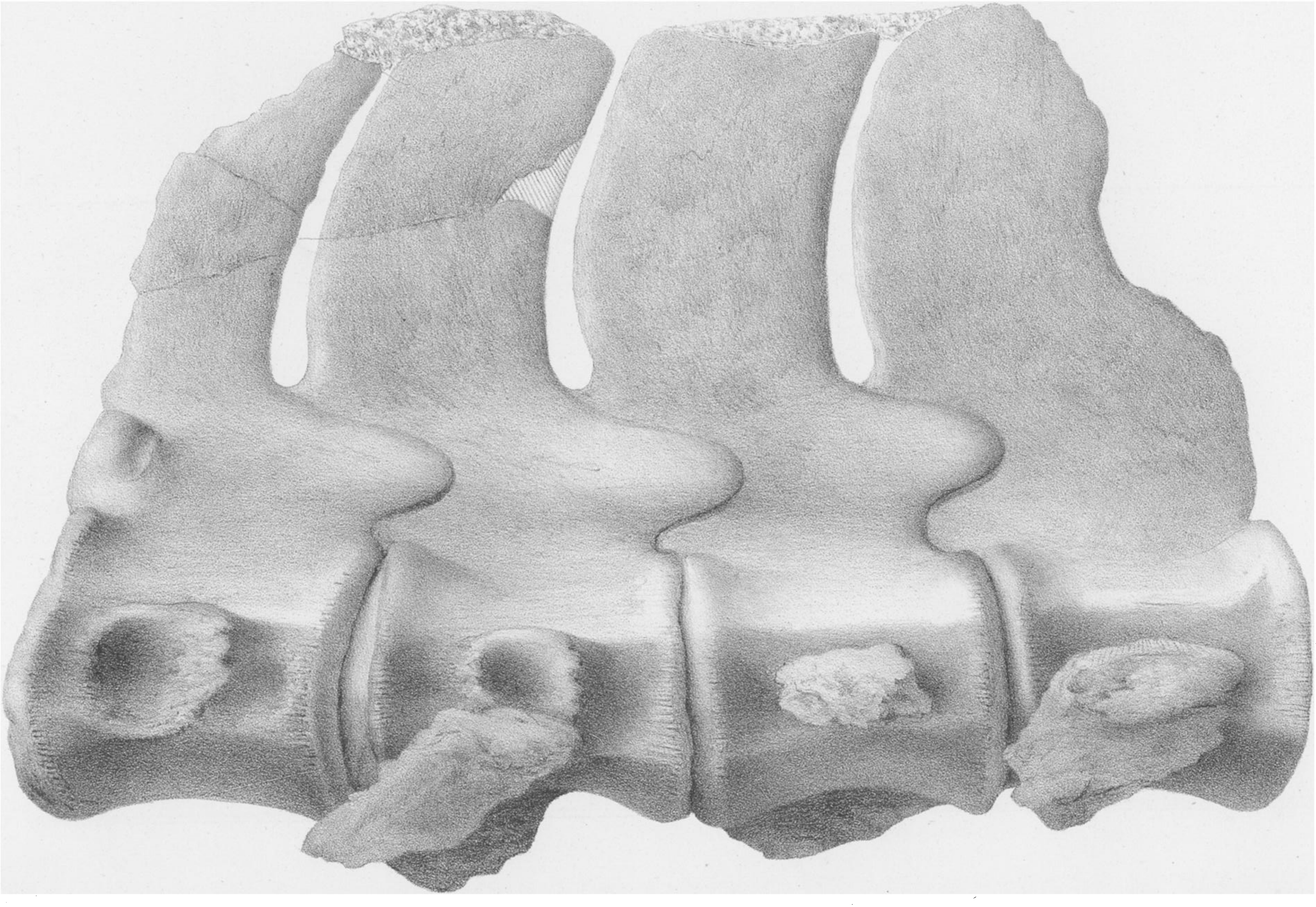

Elasmosaurus–platyurus Cope.

T. Sinclair lith. Philada.

Figs. 1–3 Holops–obscurus. 4–6 H. brevispinus. 7 H. cordatus. 8–9 Bo


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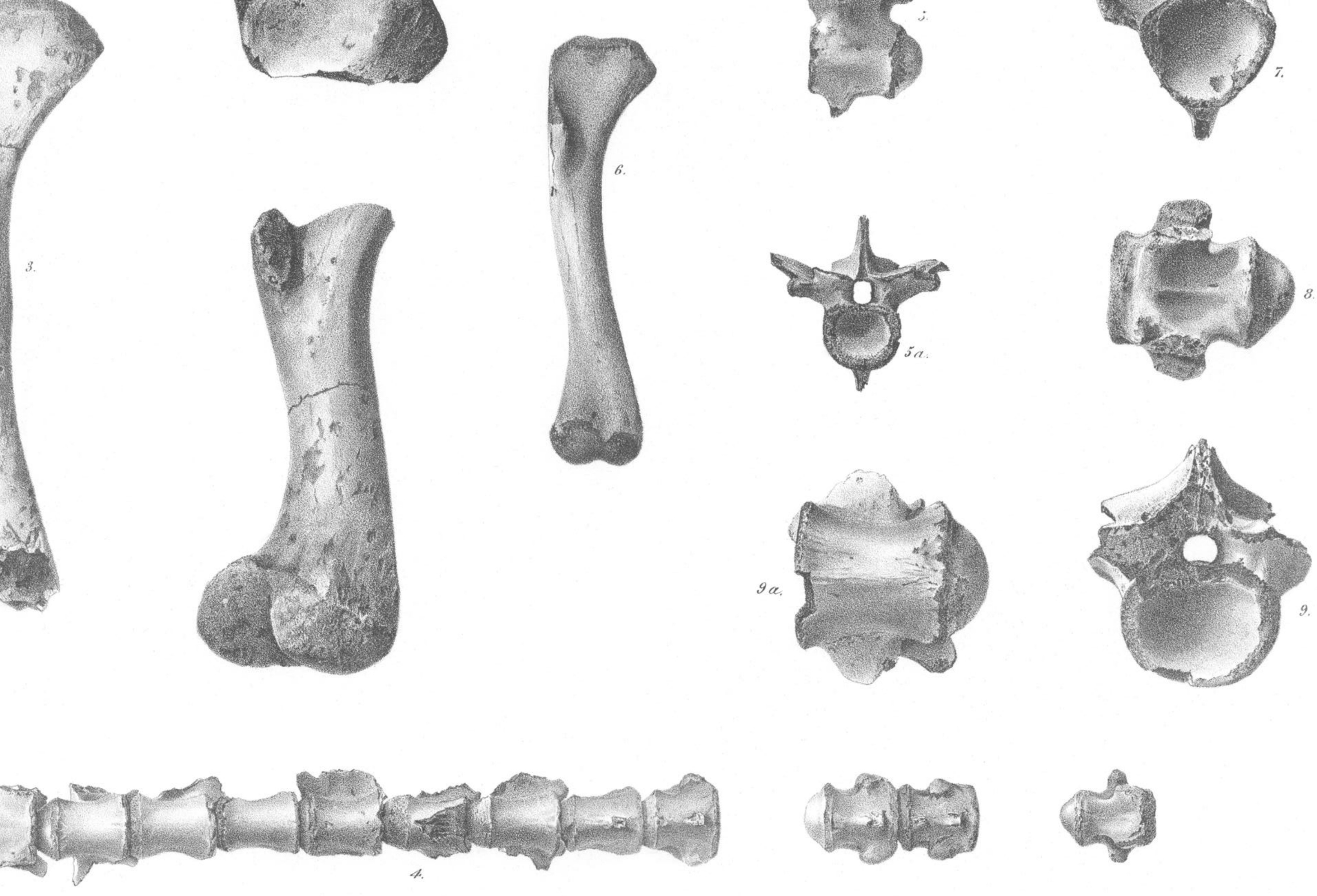

s–obscurus. 4–6 H. brevispinus. 7 H. cordatus. 8–9 Bottosaurus-harlani.

T. Sinclair's Lith. Phila.


Fig. 1.
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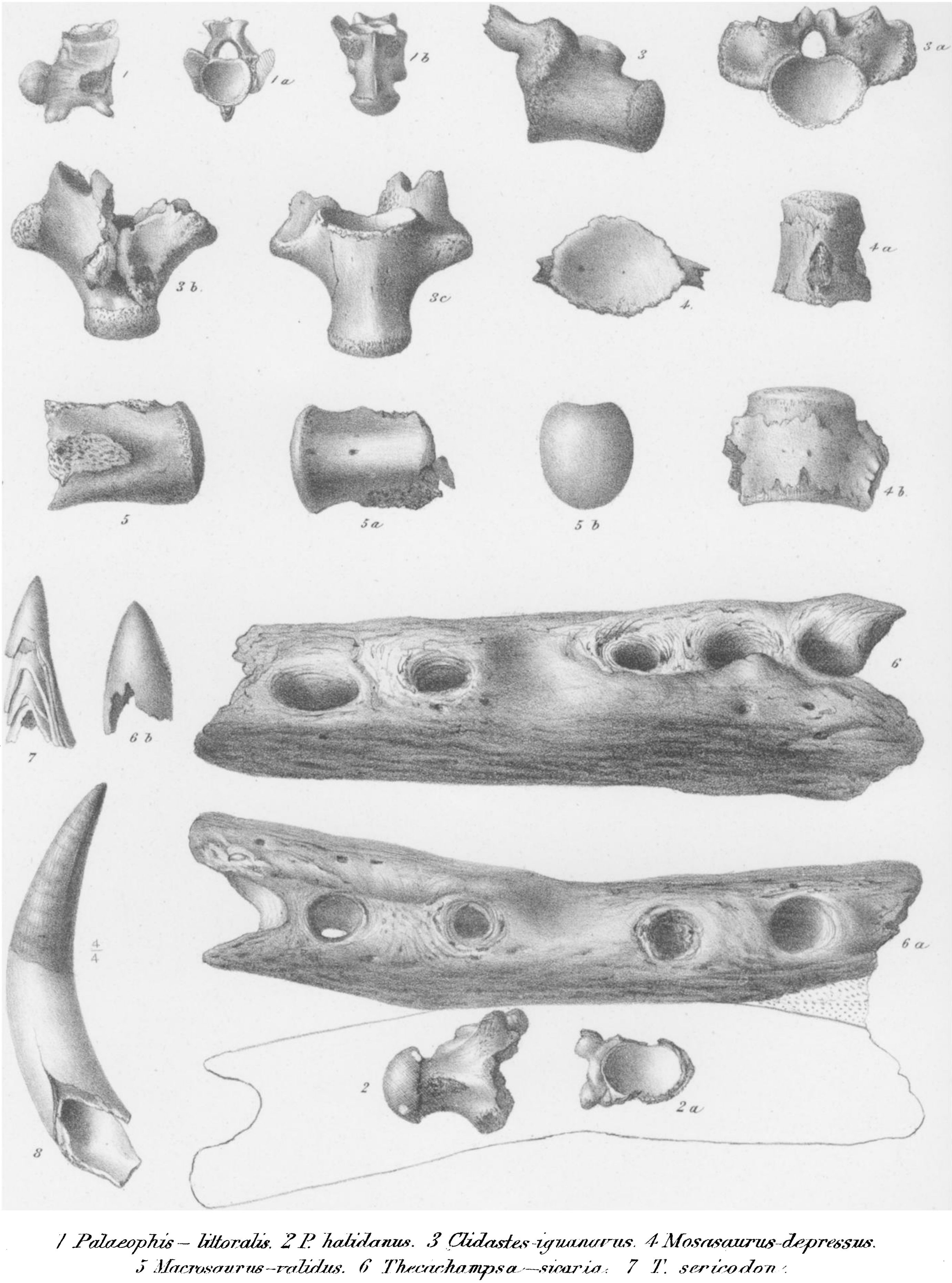
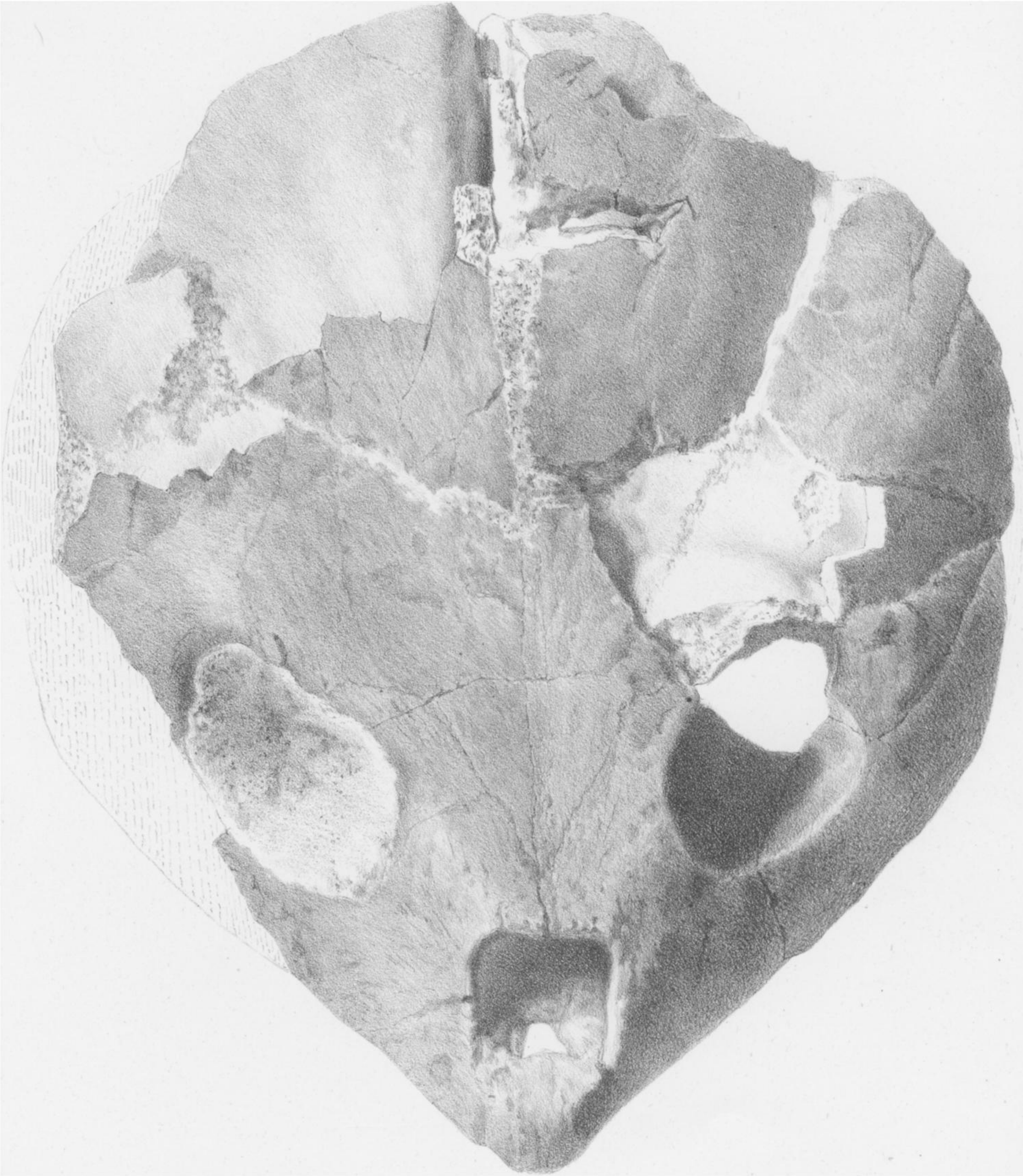
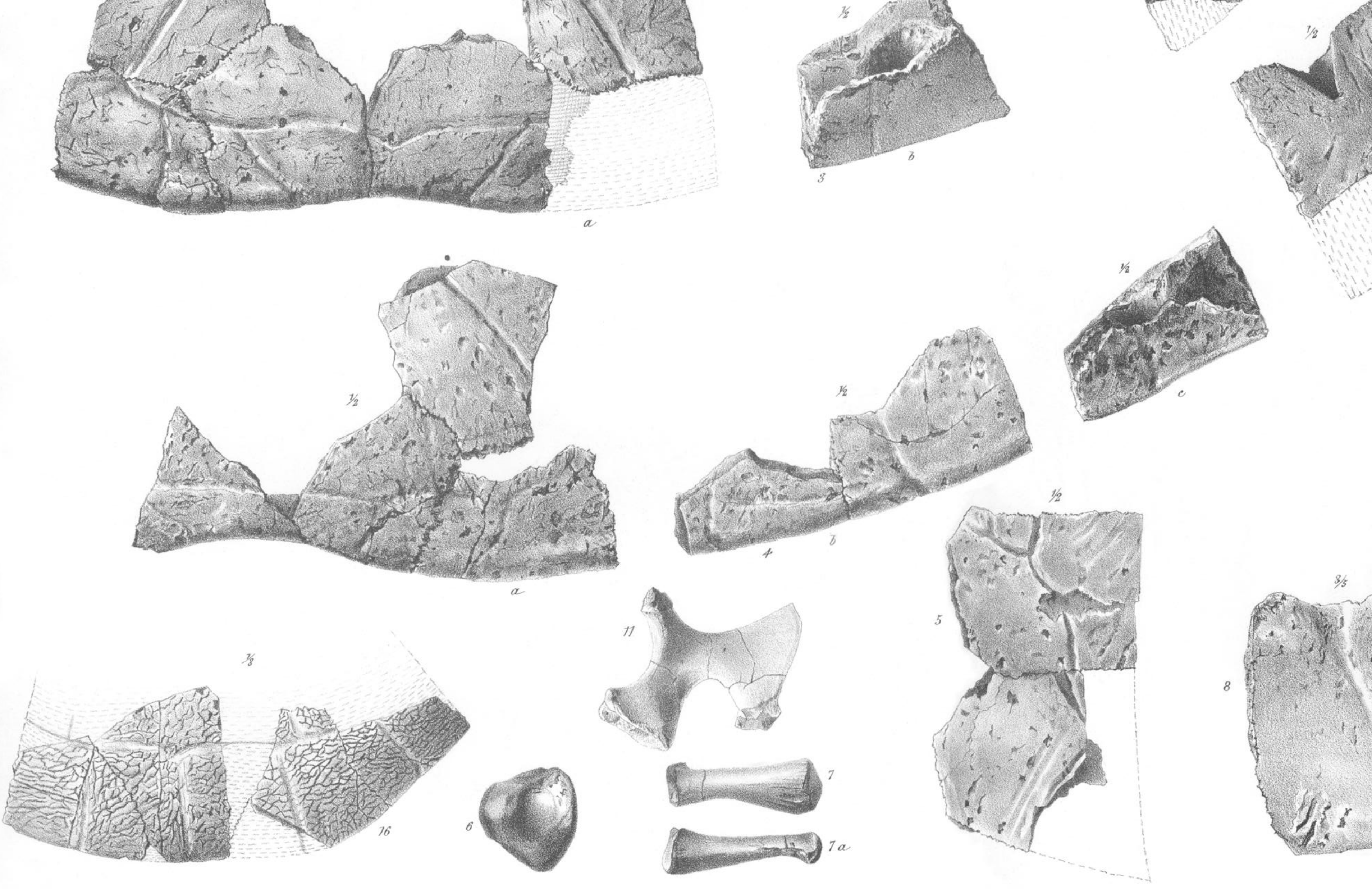


1 Palaeophis – littoralis. 2 P. halidanus. 3 Clidastes-iguanavus. 4 Mosasaurus-depressus.
5 Macrosaurus-validus. 6 Thecachampsa – sicaria. 7 T. sericodon.

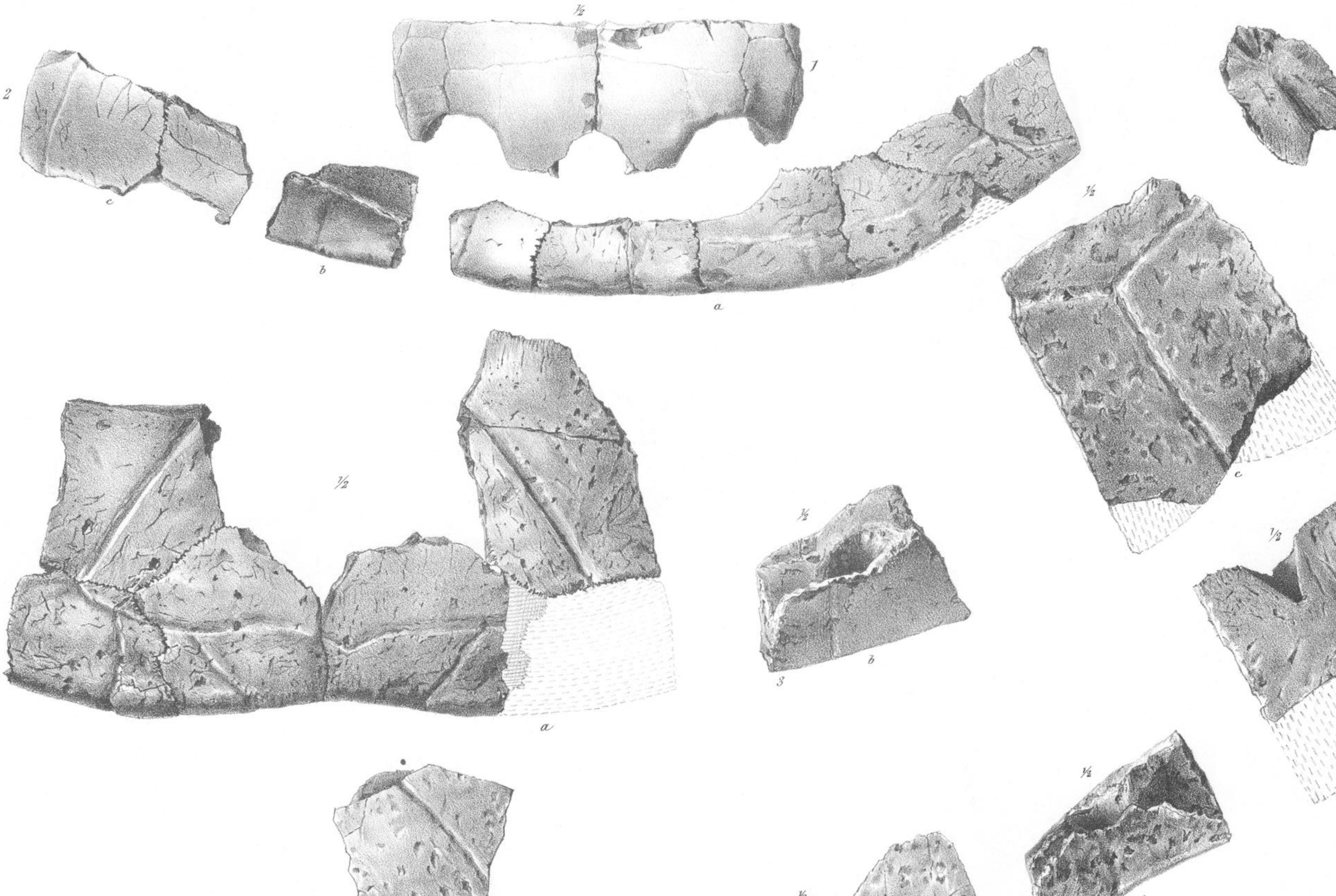


Euclastes platyops Cope.

T. Sinclair lith. Philada.



1 Pleurosternum pectorale. 2 Catapleura repanda. 3 Osteopygis emarginatus. 4-7 Propleura sopita. 8 Osteo
platyops. 10-12 Stylemys nebrascensis. 13 Trionyx pennatus. 14 T. lima. 15 T. halophilus. 16 Taphrosphys m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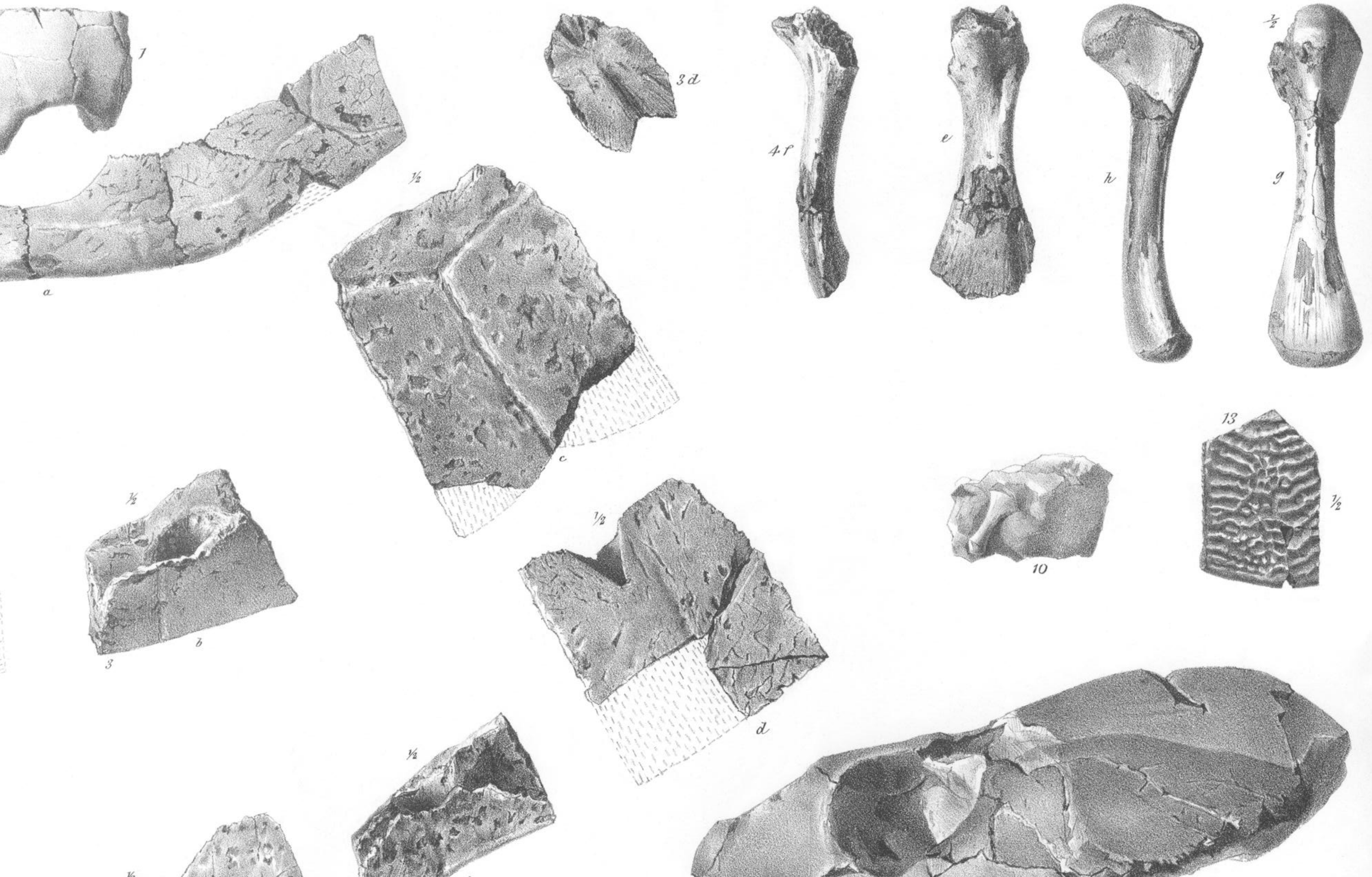
ascensis. 13 Trionyx pennatus. 14 T. lima. 15 T. halophilus. 16 Taphrosphys molops.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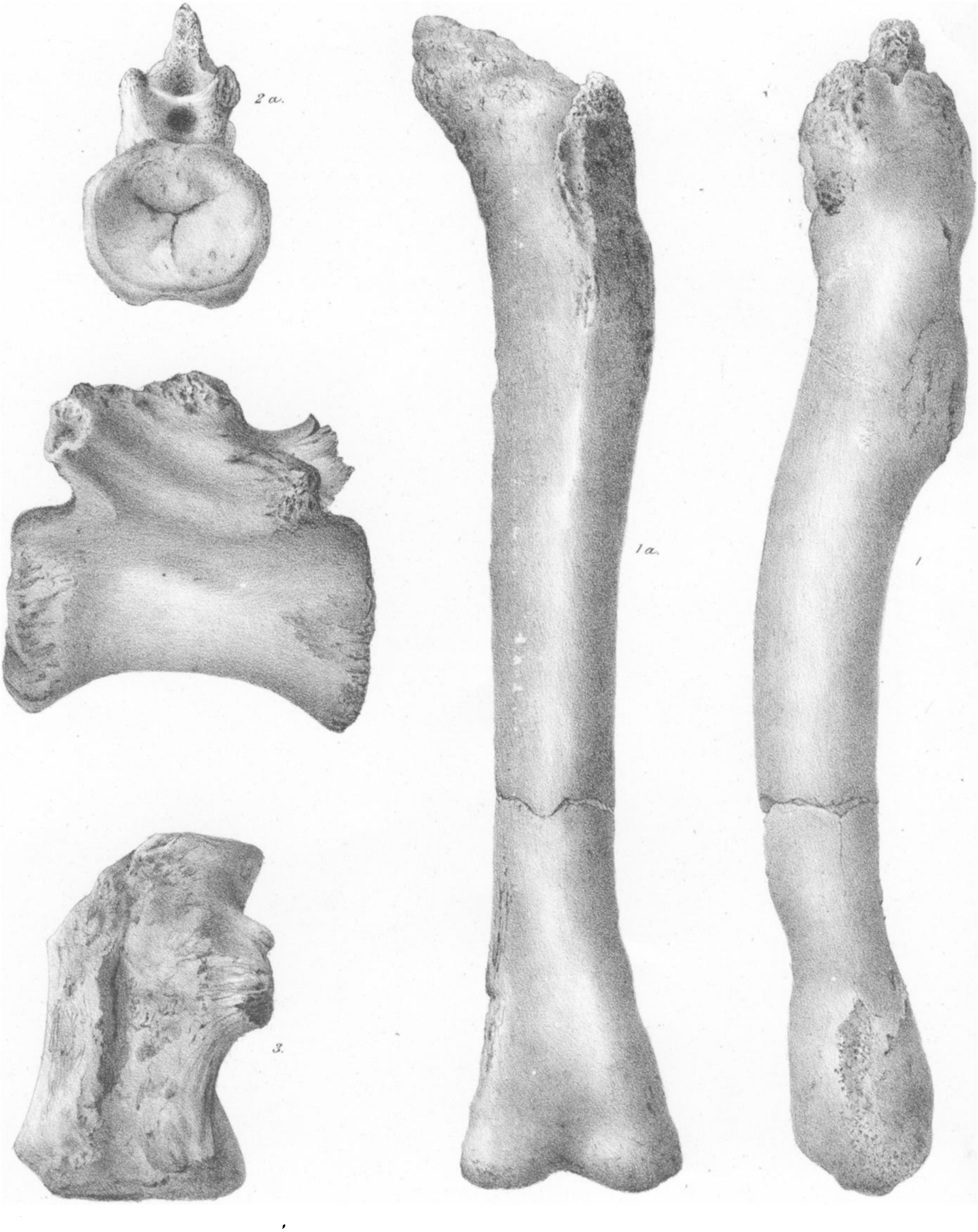
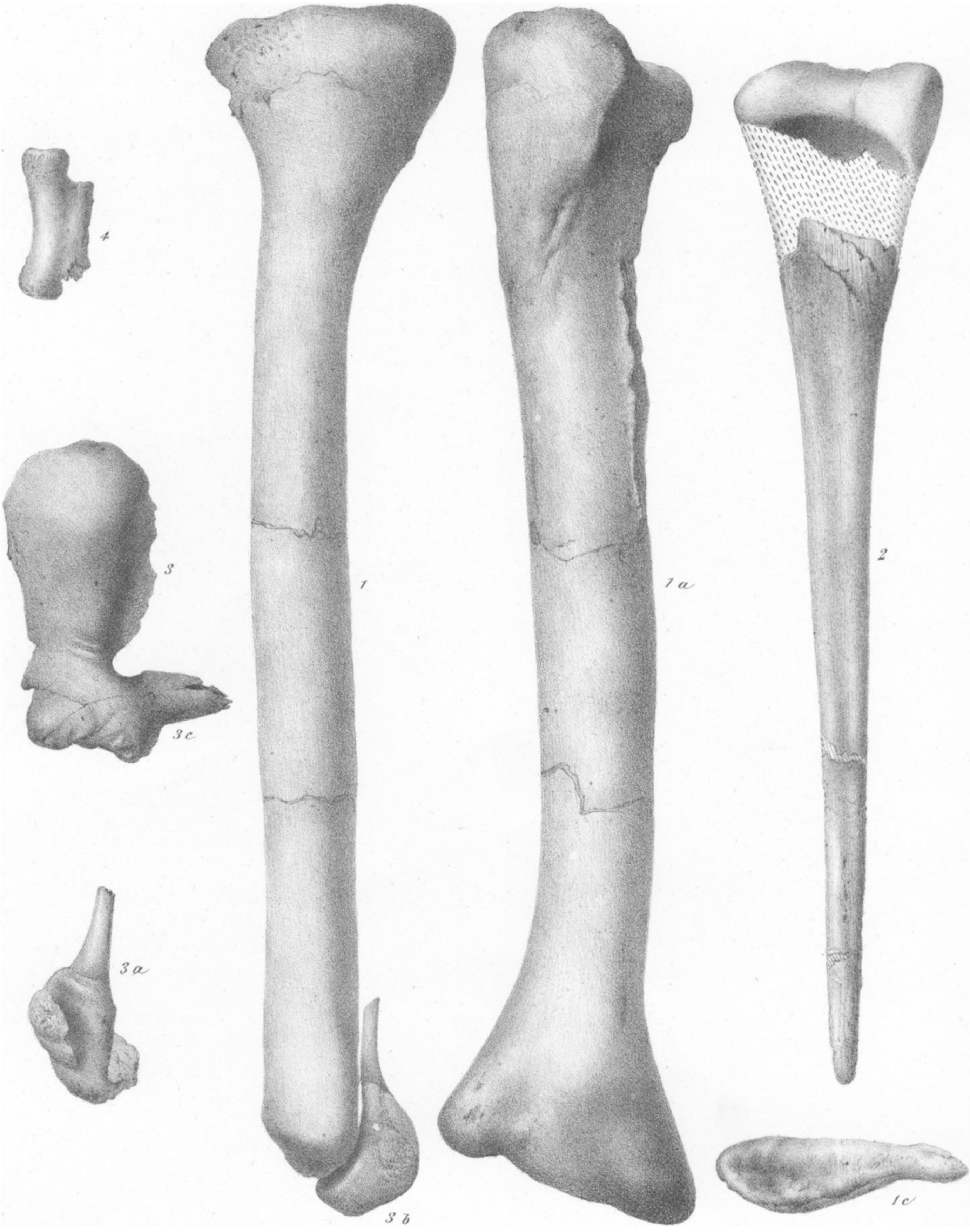
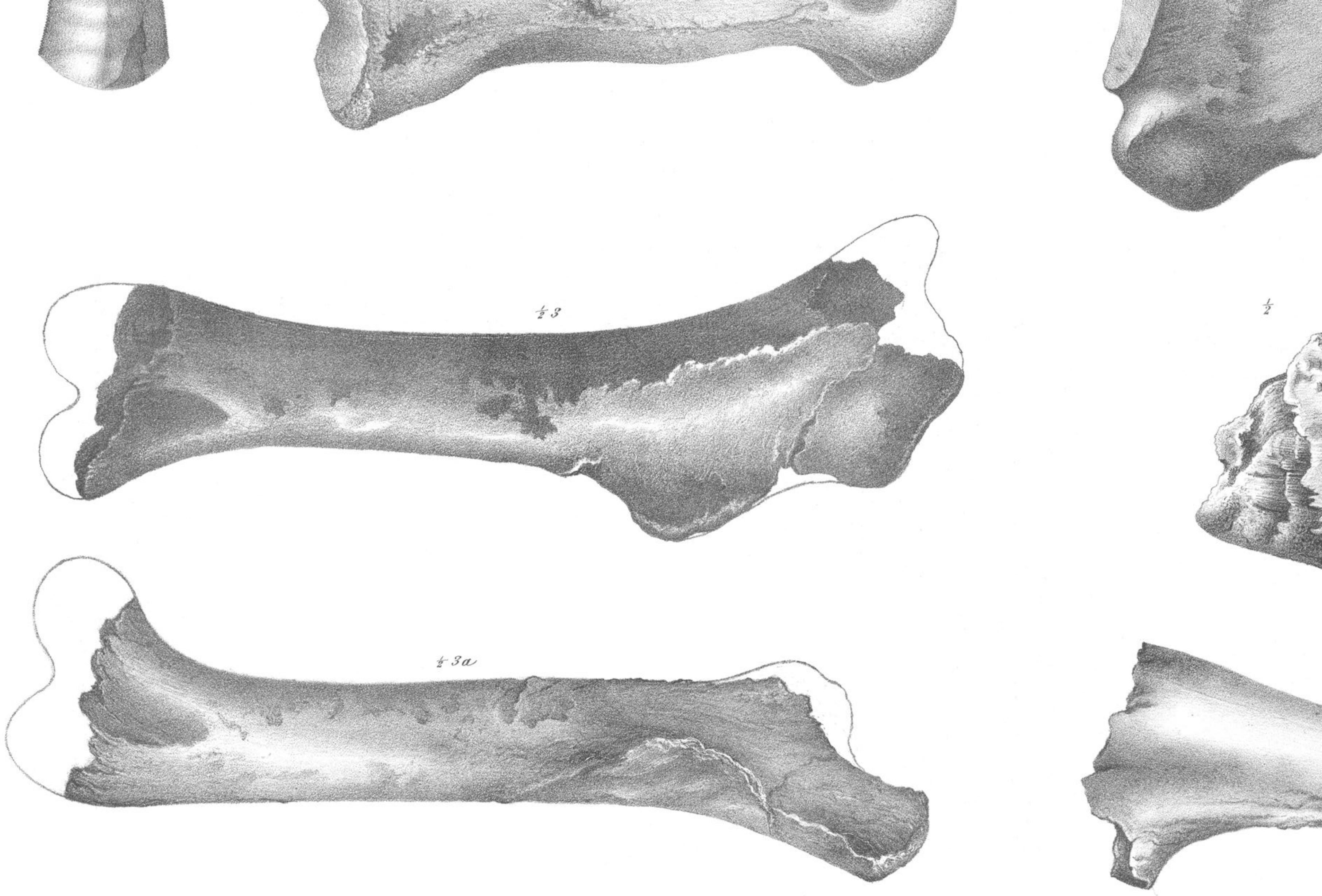


Laelaps-aquilunguis Cope.

T. Sinclair lith. Philada.

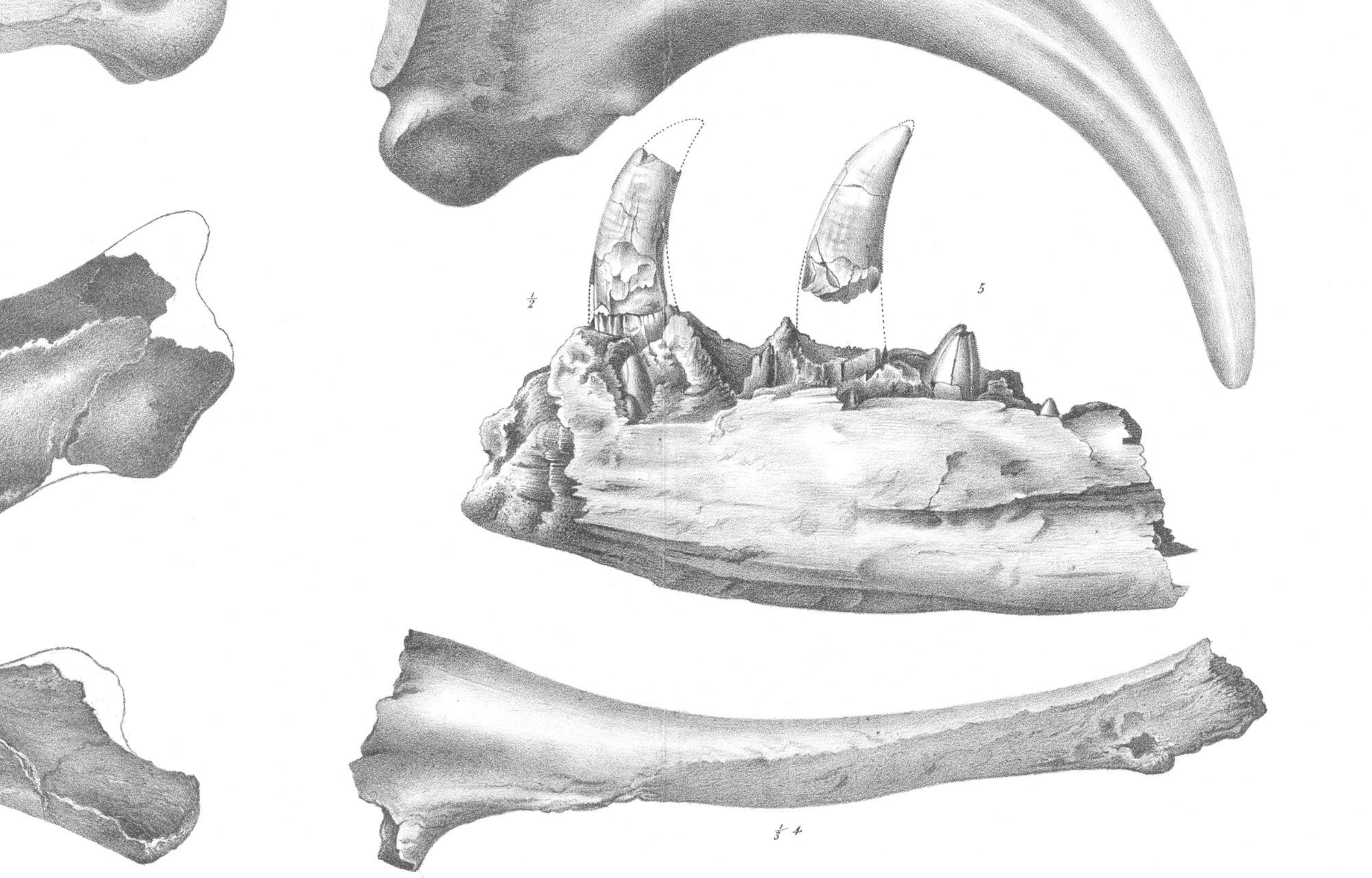


Laelaps aquilunguis.

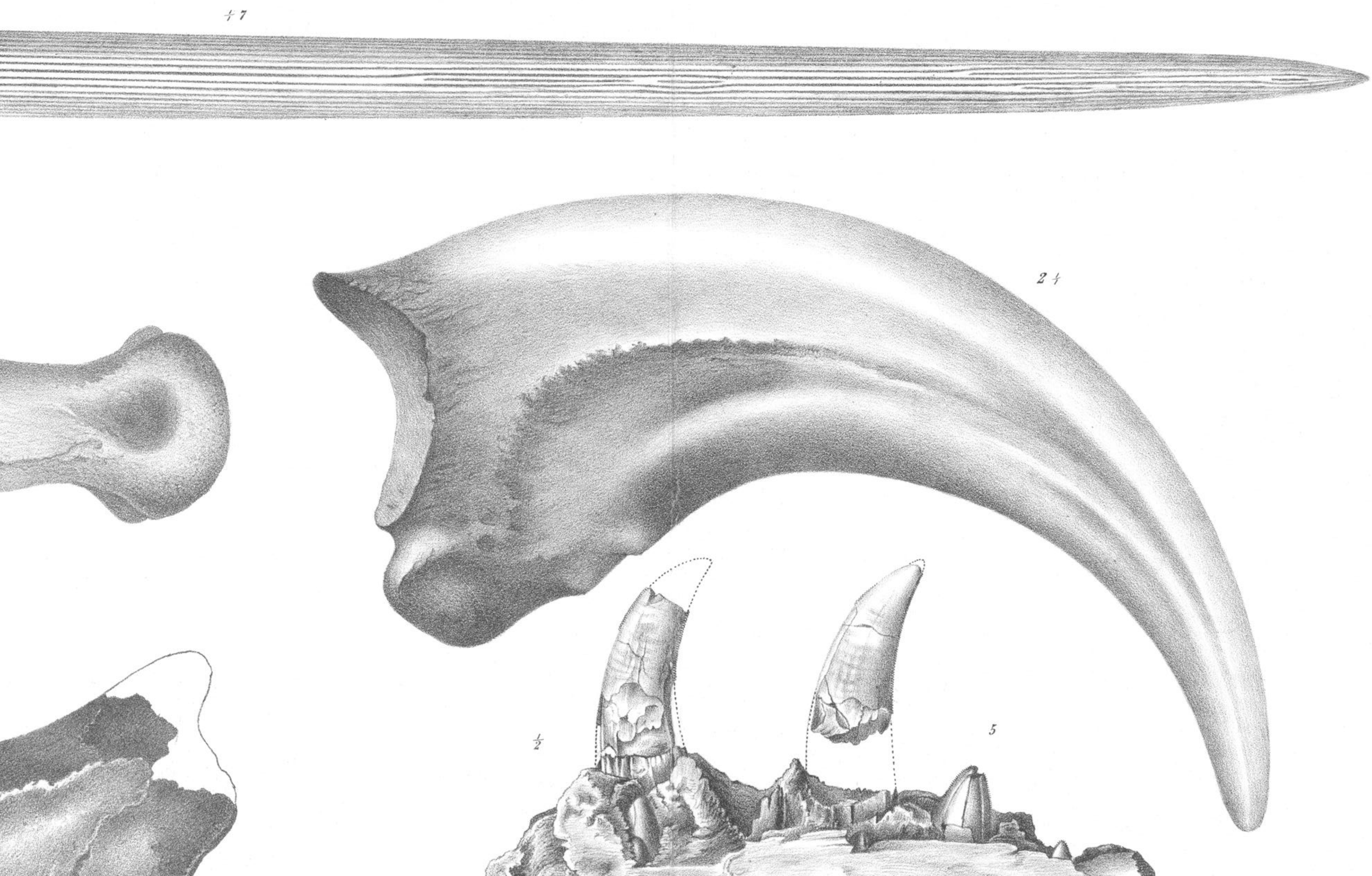


1-6 Laelaps aquilunguis. 7 Coelorhynchus ornatus.

Cope on Fossil Reptilia &c.



1-6 Laelaps aquilunguis. 7 Coelorhynchus ornatus.



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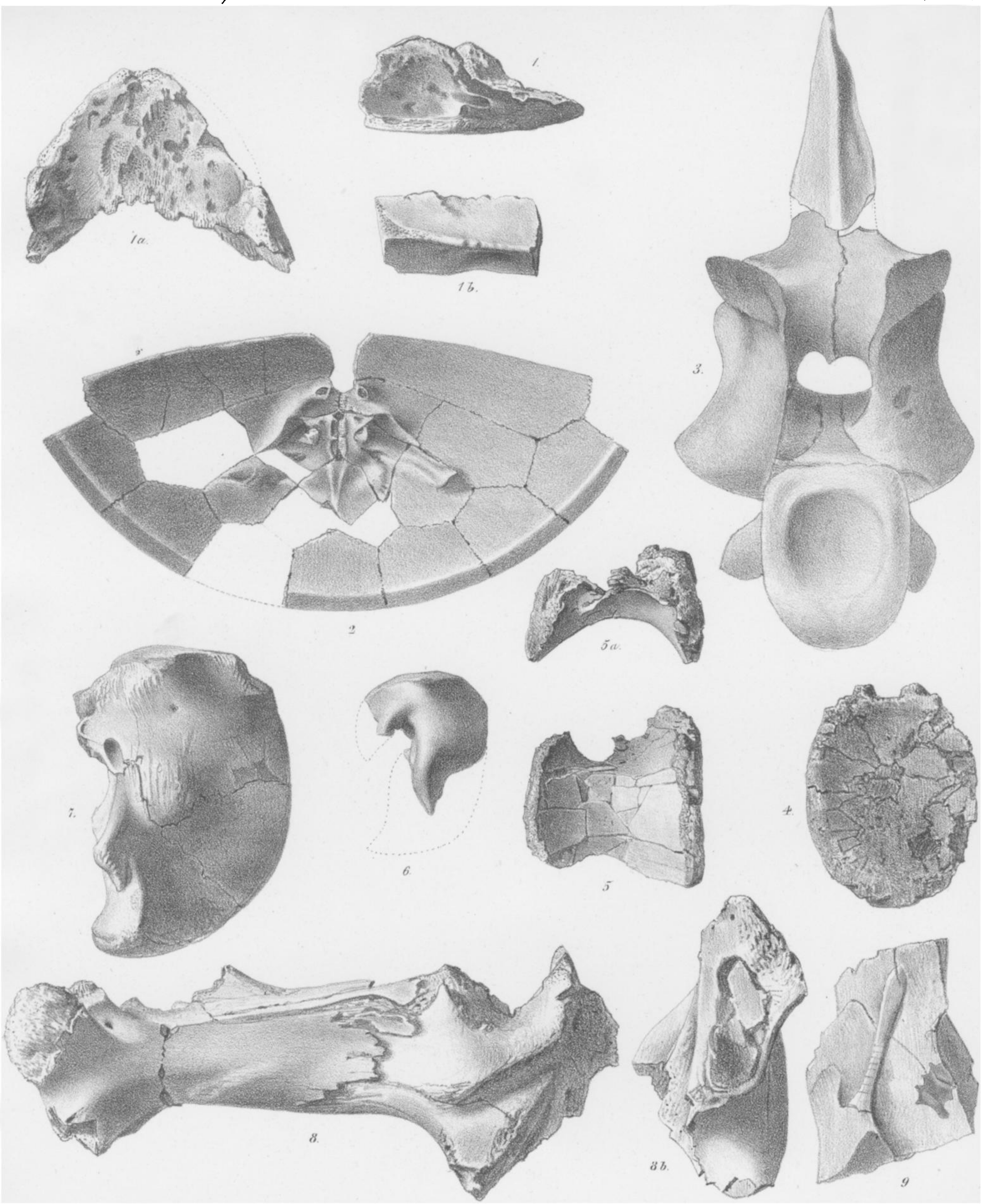
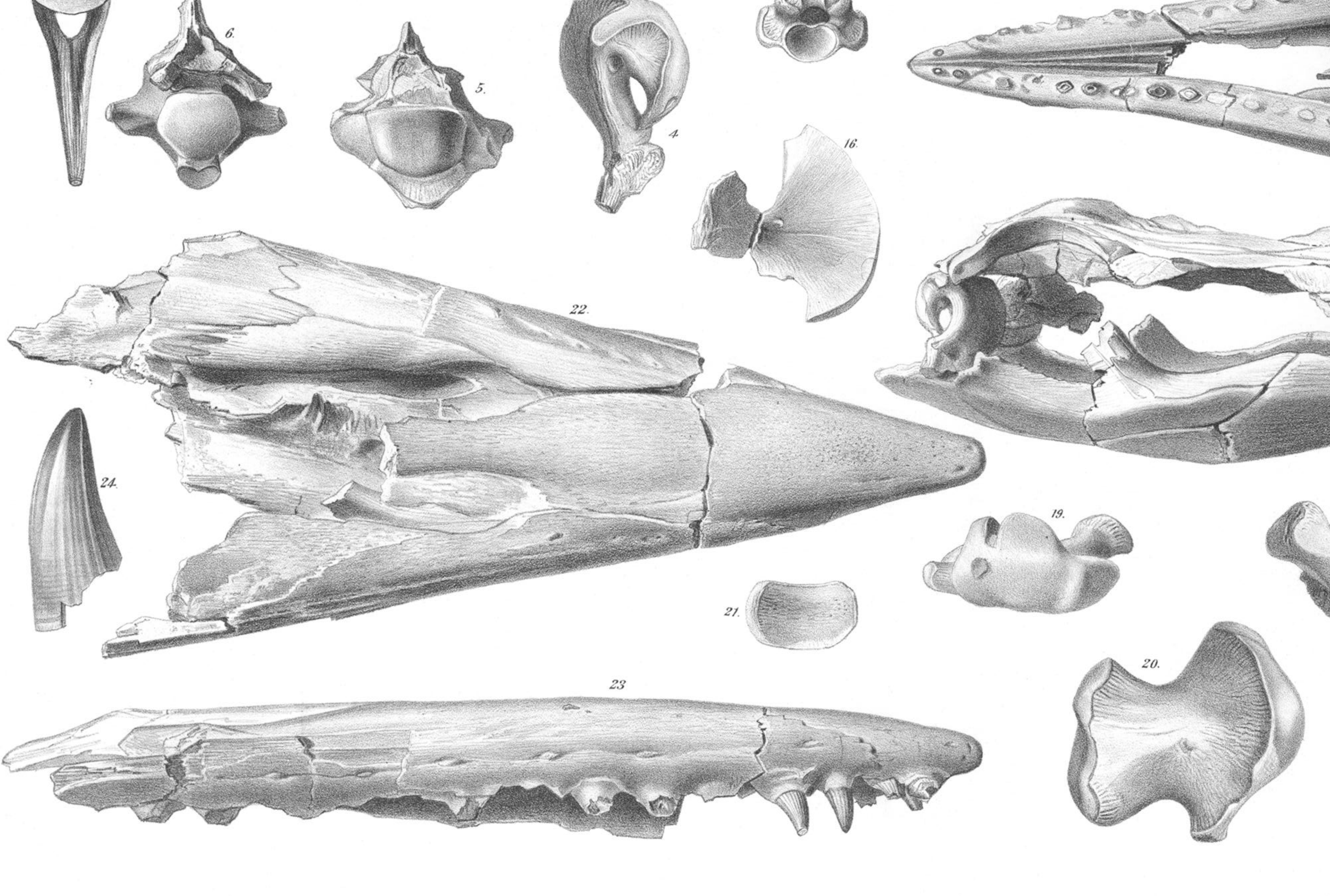


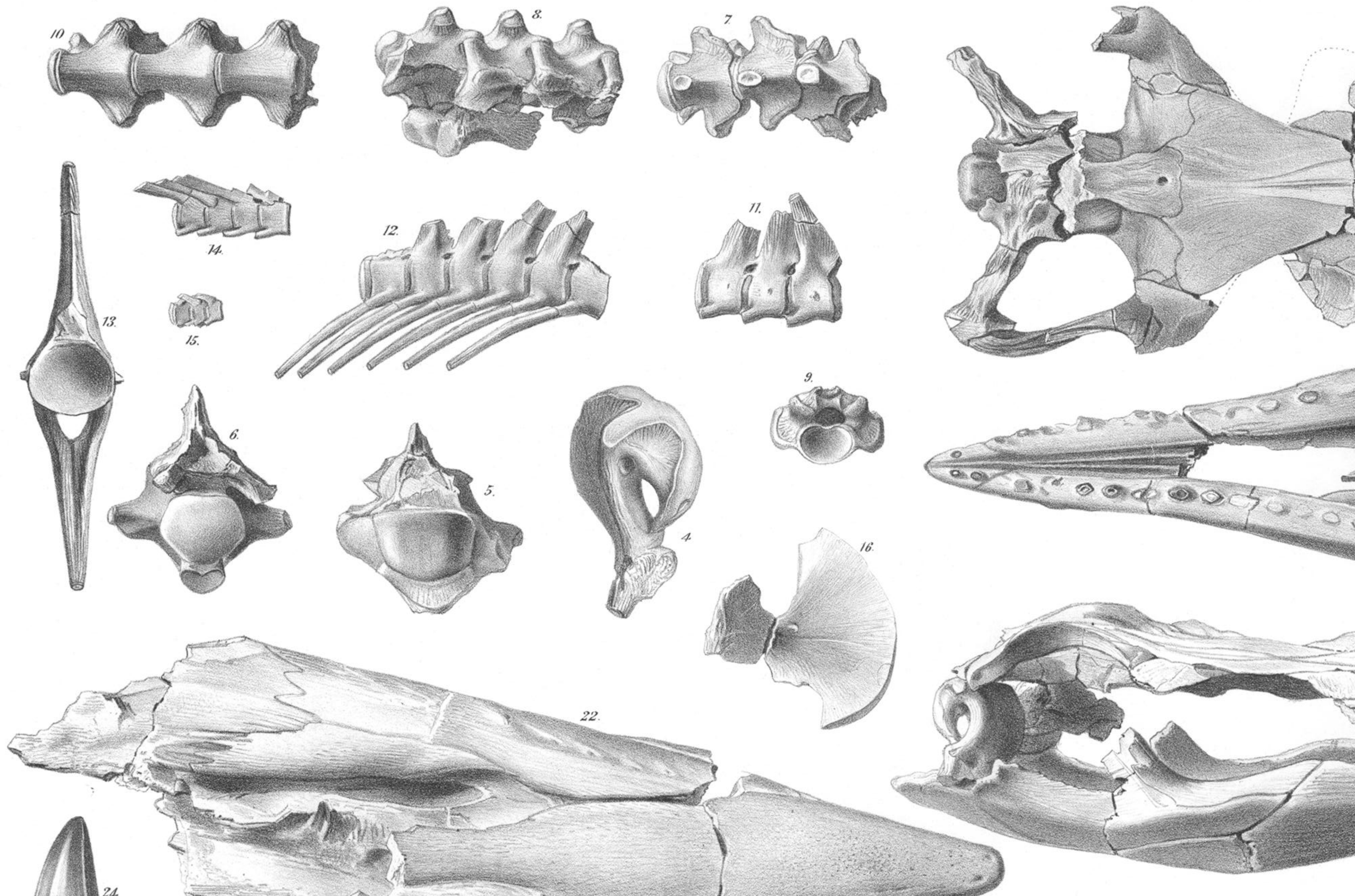
T. Sinclair lith. Philada.

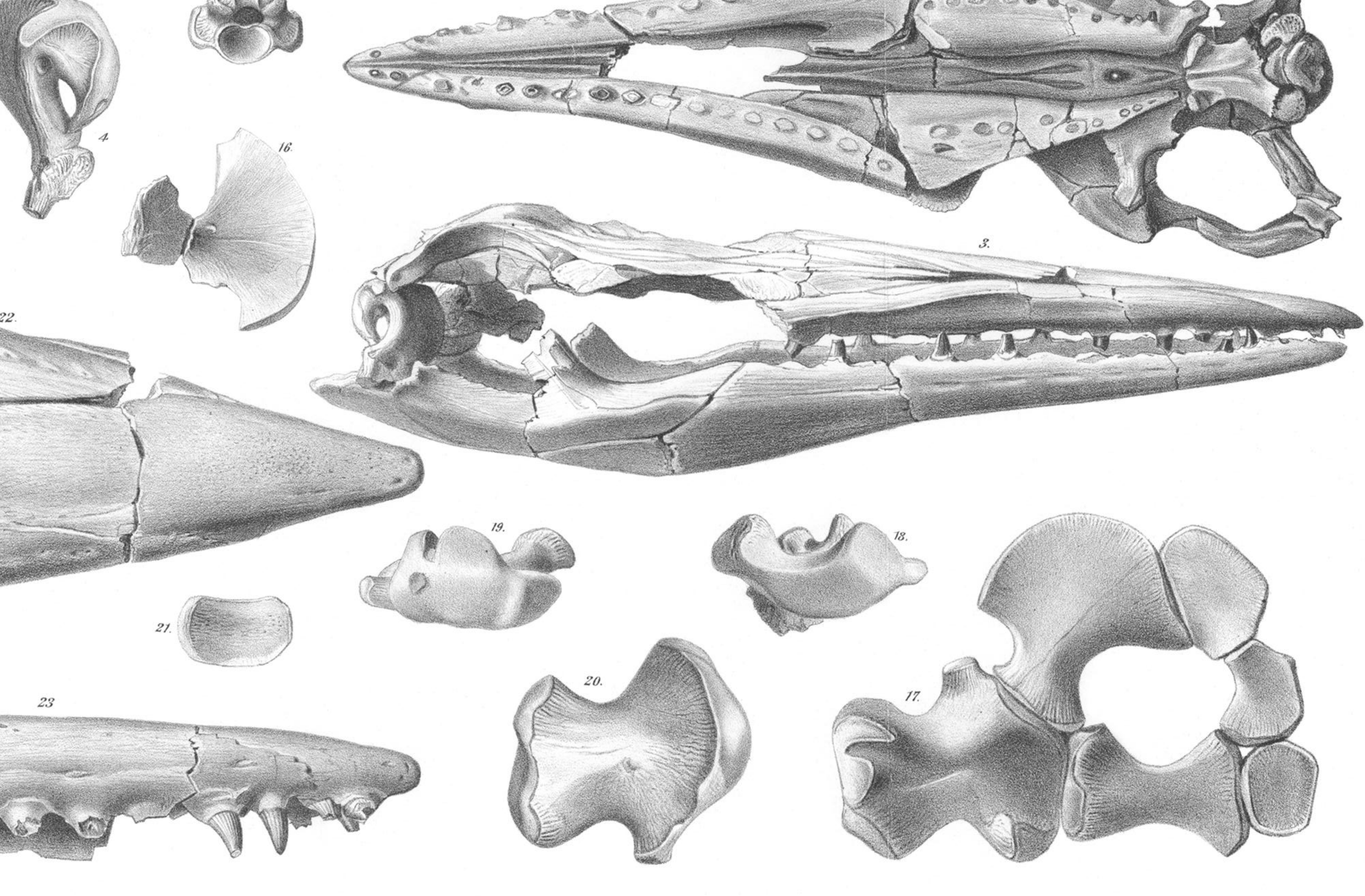
1. Lytoloma angusta. 2. Prochonias sulcatus. 3. Hyposaurus rodgersi 4.-5. Laelaps aquilunguis.
6. Mosasaurus depressus. 7. M maximus. 8 M. mitchellii. 9. Rhabdopelix longispinis.



1-21 Clidastes propython. 22-24 Macrosaurus proriger.

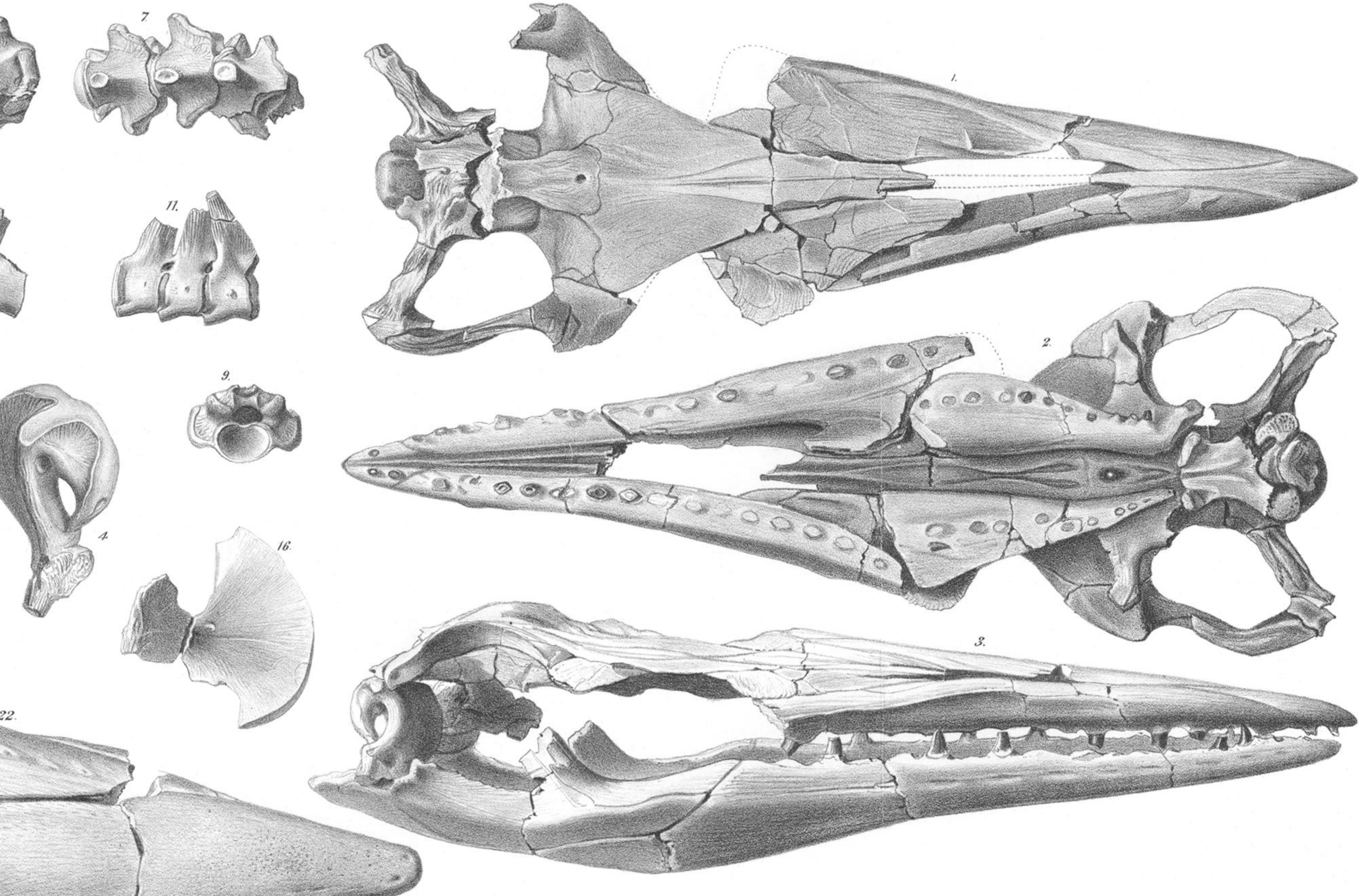
Cope on Fossil Reptilia &c.

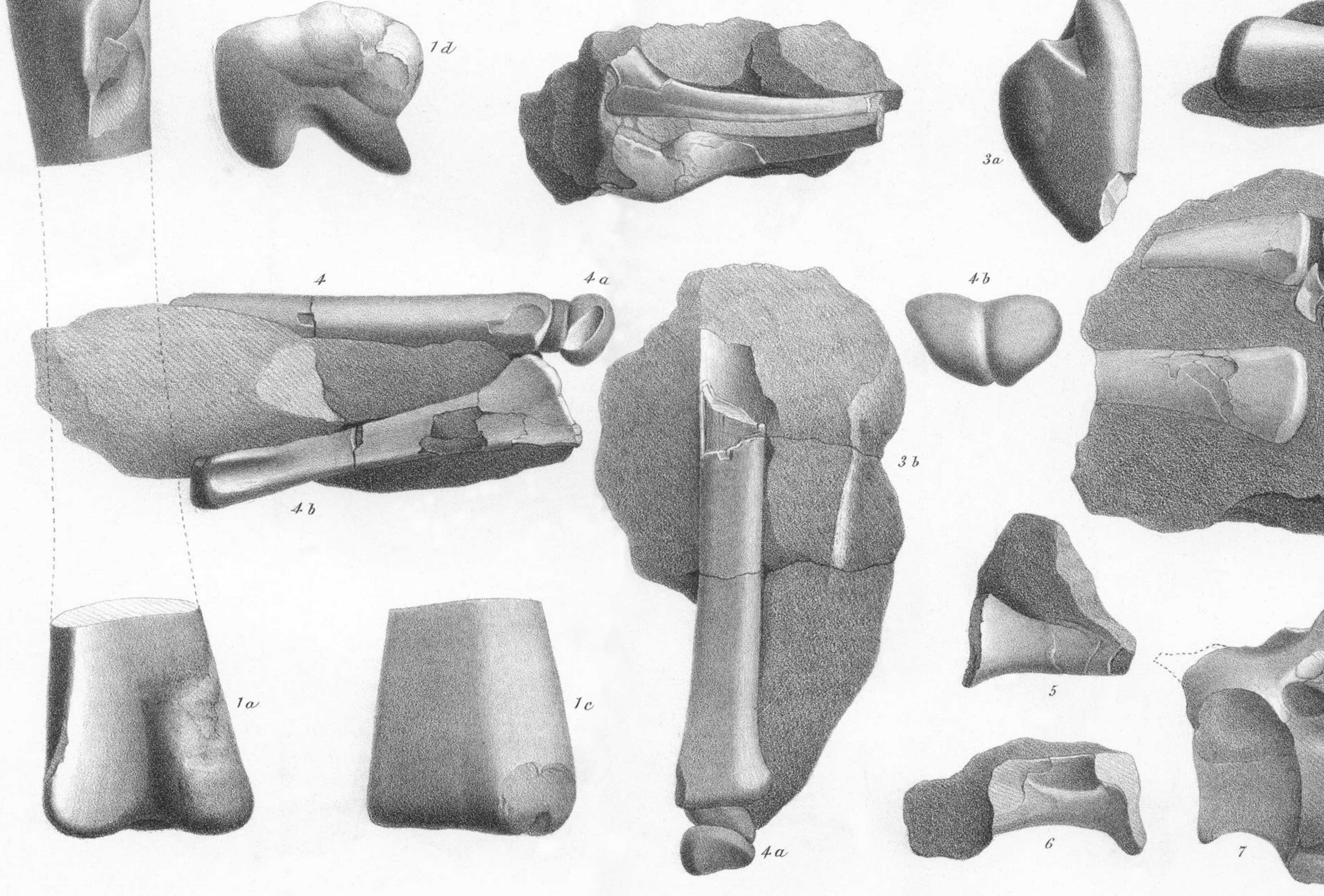




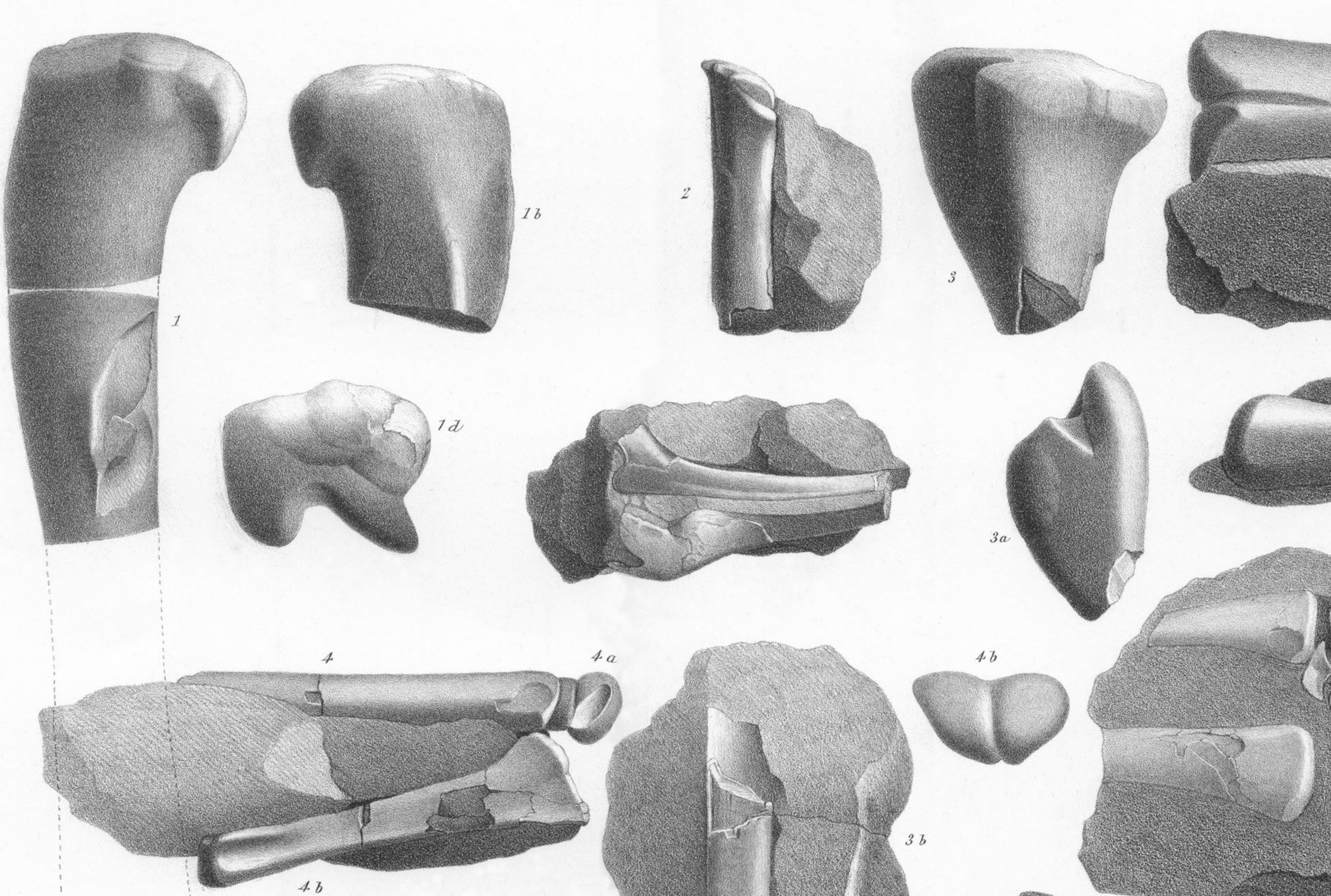
1-21 *Clidastes propython.* 22-24 *Macrosaurus proriger.*

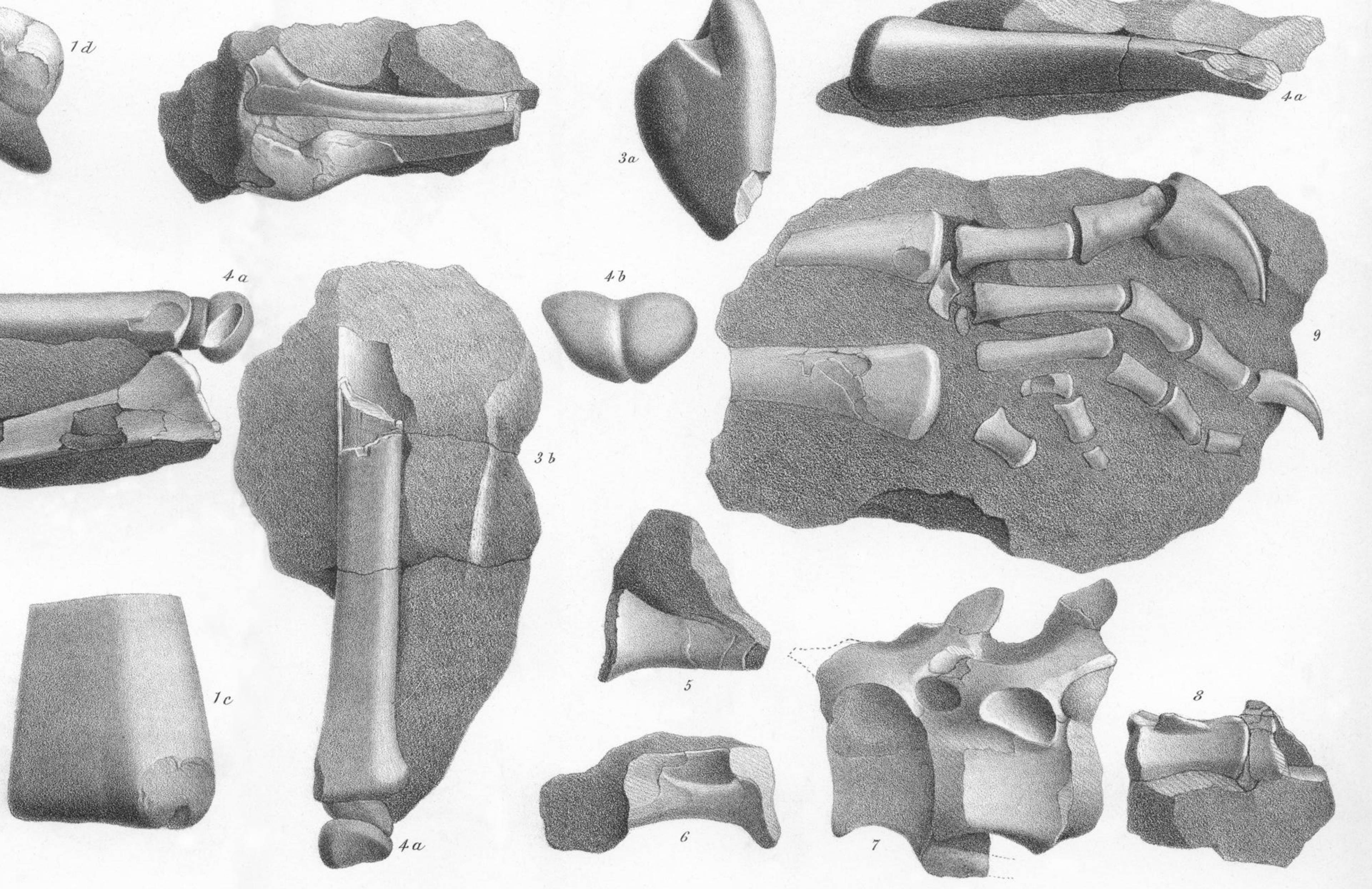
T. Sinclair lith., Philada.


7.
11.
9.
4.
16.
22.
1.
2.
3.

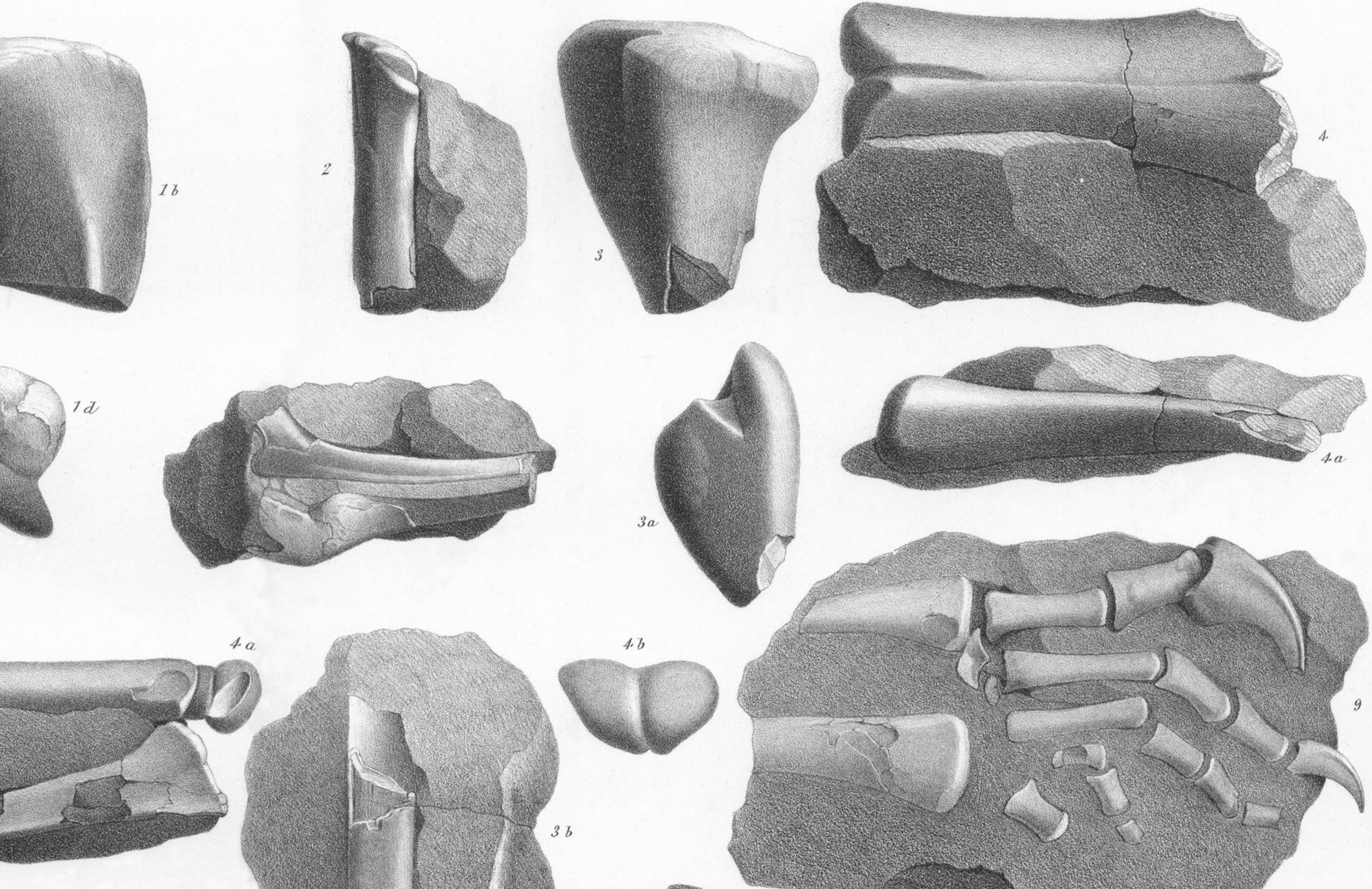


1-9 Megadactylus poly zelus Hitch.


1
1b
1d
2
3
3a
3b
4
4a
4b
4b



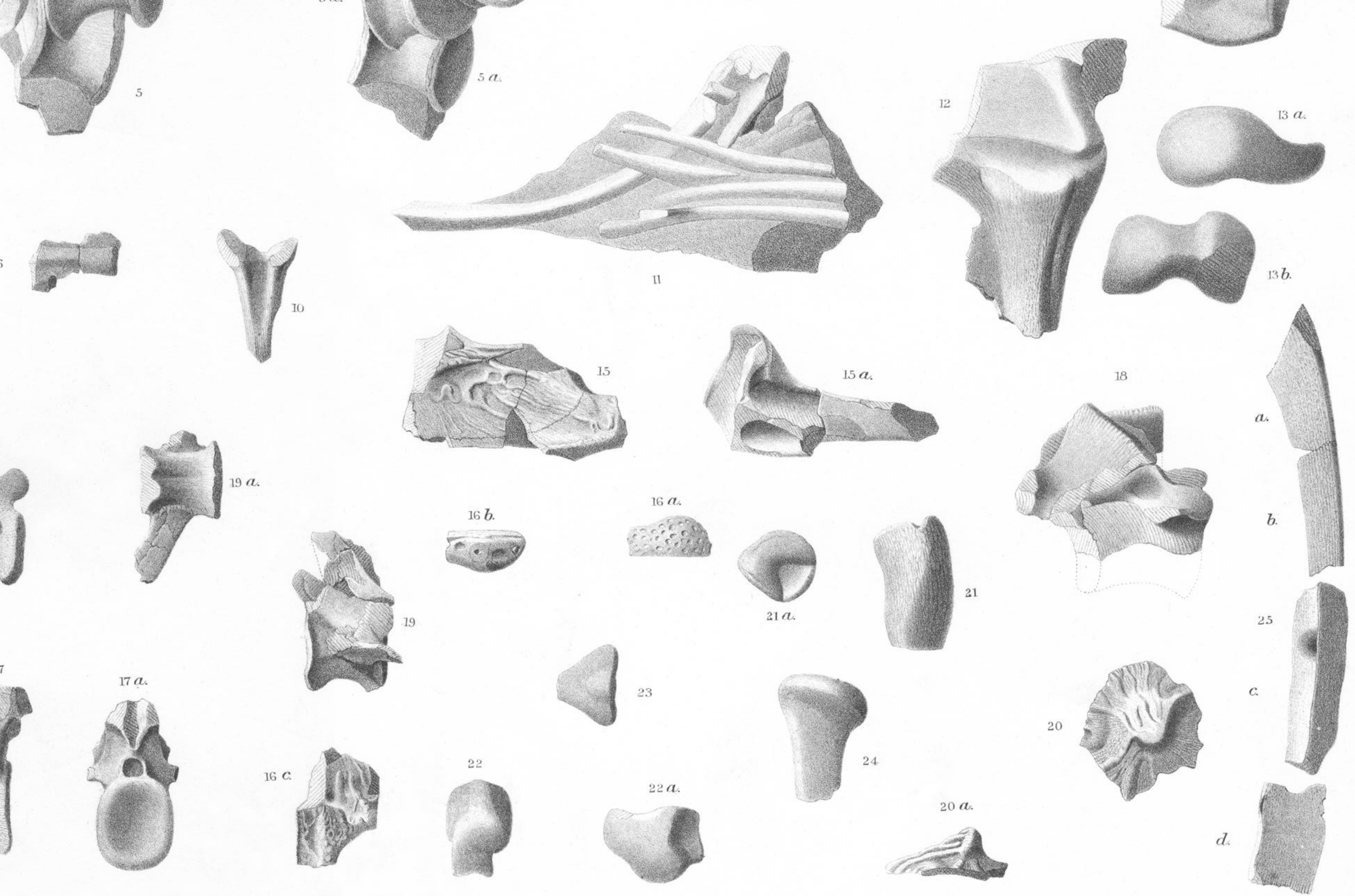
1–9 *Megadactylus poly zelus Hitch.*


1 b
2
3
4
1 d
3 a
4 a
4 a
4 b
3 b
9

Edwin Sheppard, del.

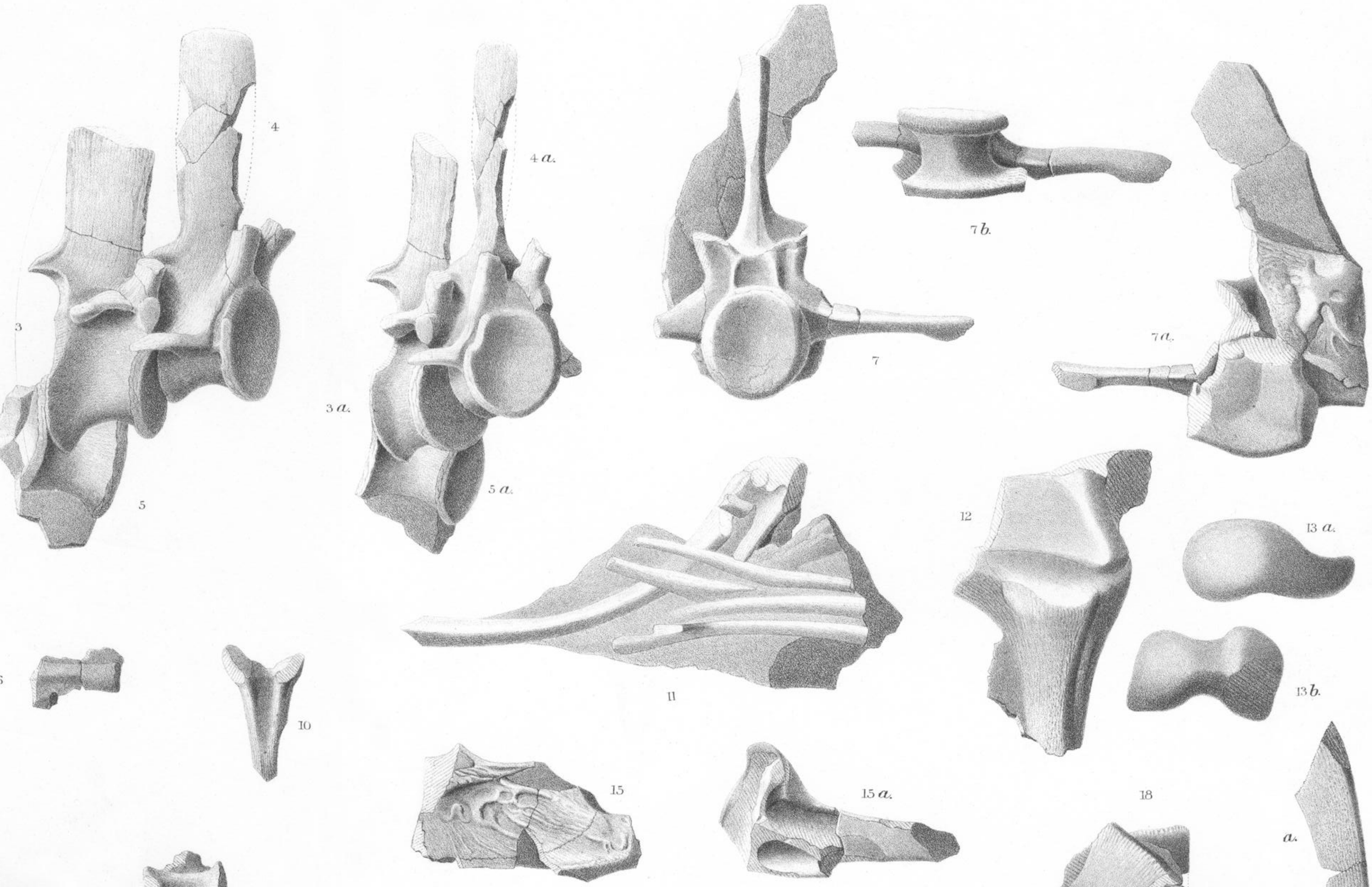
1-14. BELODON LEPTURUS. 15-24. BELODON PRISCUS. 25. LYTOLOMA JEANSEI. ⅓ Na


1
1a.
4
4a.
3
3a.
8
8a.
5
5a.
2
6
10
11
9a.
15
9



…ODON LEPTURUS. 15-24. BELODON PRISCUS. 25. LYTOLOMA JEANSEI. ⅓ Nat. Size.

Bowen & C^o lith. Phil^a.


3
4
5
4 a.
3 a.
5 a.
7
7 b.
7 a.
11
12
13 a.
13 b.
10
15
15 a.
18
a.